Cochrane Library

Cochrane Database of Systematic Reviews

Patient reminder and recall systems to improve immunization rates (Review)

Jacobson Vann JC, Szilagyi P

Jacobson Vann JC, Szilagyi P.
Patient reminder and recall systems to improve immunization rates.
Cochrane Database of Systematic Reviews 2005, Issue 3. Art. No.: CD003941.
DOI: 10.1002/14651858.CD003941.pub2.

www.cochranelibrary.com

WILEY

TABLE OF CONTENTS

[Intervention Review]

Patient reminder and recall systems to improve immunization rates

Julie C Jacobson Vann[1], Peter Szilagyi[2]

[1]School of Nursing, Health Care Systems, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA. [2]Pediatrics, University of Rochester School of Medicine & Dentistry, Rochester, USA

Contact address: Julie C Jacobson Vann, School of Nursing, Health Care Systems, University of North Carolina at Chapel Hill, Carrington Hall, CB 7460, Chapel Hill, North Carolina, 27599-7460, USA. jvann@email.unc.edu.

Editorial group: Cochrane Effective Practice and Organisation of Care Group.
Publication status and date: Edited (no change to conclusions), published in Issue 1, 2010.

Citation: Jacobson Vann JC, Szilagyi P. Patient reminder and recall systems to improve immunization rates. *Cochrane Database of Systematic Reviews* 2005, Issue 3. Art. No.: CD003941. DOI: 10.1002/14651858.CD003941.pub2.

ABSTRACT

Background

Immunization rates for children and adults are rising, but coverage levels have not reached optimal goals. As a result of low immunization rates, vaccine-preventable diseases still occur. In an era of increasing complexity of immunization schedules, rising expectations about the performance of primary care, and large demands on primary care physicians, it is important to understand and promote interventions that work in primary care settings to increase immunization coverage. A common theme across immunization programs in all nations involves the challenge of determining the denominator of eligible recipients (e.g. all children who should receive the measles vaccine), and identifying the best strategy to ensure high vaccination rates. Strategies have focused on patient-oriented interventions (e.g. patient reminders), provider interventions, and system interventions. One intervention strategy involves patient reminder and recall systems.

Objectives

To assess the effectiveness of patient reminder and recall systems in improving immunization rates, and compare the effects of various types of reminders in different settings or patient populations.

Search methods

A systematic search was performed for the initial review using MEDLINE (1966-1998) and 4 other bibliographic databases: EMBASE, PsychINFO, Sociological Abstracts, and CAB Abstracts. Authors also performed a search of The Effective Practice and Organisation of Care (EPOC) register in April 2001 to update the review. Two authors reviewed the lists of titles and abstracts, and used the inclusion criteria to mark potentially relevant articles for full review. The reference lists of all relevant articles and reviews were back searched for additional studies. Publications of abstracts, proceedings from scientific meetings, and files of study collaborators were also searched for references. In May 2007 the EPOC register was searched to identify relevant articles to update the review. In May 2007, the EPOC register search was supplemented by searches of CINAHL and PubMed. One study was identified through prior knowledge of this study.

Selection criteria

Study Design

Randomized controlled trials (RCT), controlled before and after studies (CBA), and interrupted time series (ITS) studies written in English.

Types of participants

Health care personnel who deliver immunizations and children (birth to 18 years) or adults (18 years and up) who receive immunizations in any setting.

Types of interventions

Any intervention that falls within the EPOC scope and that includes patient reminder or recall systems, or both, in at least one arm of the study.

Types of outcome measures

Immunization rates, or the proportion of the target population up-to-date on recommended immunizations. Outcomes were acceptable for either individual vaccinations (e.g. influenza vaccination) or standard combinations of recommended vaccinations (e.g. all recommended vaccinations by a specific date or age).

Data collection and analysis

Data Collection

Each study was read independently by two reviewers. Disagreements between reviewers were resolved by a formal reconciliation process to achieve consensus.

Analysis

Results are presented for individual studies as relative rates for randomized controlled trials, and as absolute changes in percentage points for controlled before and after studies. Pooled results for RCTs only were for presented using the random effects model.

Main results

Four new studies were added for the 2007 update for a total of 47 studies. Increases in immunization rates due to reminders were in the range of 1 to 20 percentage points. Reminders were effective for childhood vaccinations (OR = 1.47, 95% CI =1.28, 1.68), childhood influenza vaccinations (OR = 2.18, 95% CI = 1.29, 3.70), adult pneumococcus, tetanus, and Hepatitis B (OR = 2.19, 95%CI = 1.21, 3.99), and adult influenza vaccinations (OR = 1.66, 95% CI = 1.31, 2.09). The effectiveness of patient reminders for childhood influenza vaccinations declined overall from an odds ratio of 2.87 in the previous review. However, reminders were not effective in the one new study of adolescent immunizations in an urban setting (OR = 1.14, 95% CI = 0.98, 1.31). All types of reminders were effective (postcards, letters, telephone or autodialer calls), with telephone being the most effective but also the most costly.

Authors' conclusions

Patient reminder and recall systems in primary care settings are effective in improving immunization rates in developed countries.

PLAIN LANGUAGE SUMMARY

Does reminding people to have vaccinations increase the number of people who receive vaccinations?

Increasing the number of people who are vaccinated could lower death and disease rates throughout the world. Many strategies to increase vaccinations have been used. One way is to remind people to receive their vaccinations. This review of 47 studies evaluated whether reminding people worked.

This review found that reminding people to have vaccinations increased the number of people vaccinated, whether the people were due or overdue for vaccinations. The increases were observed in both children and adults for all types of vaccines, but not among urban adolescents in one study. Reminding people over the telephone, sending a letter or postcard, or speaking to them in person increased vaccinations. Providing numerous reminders was more effective than single reminders. Reminding people over the telephone was more effective than postcard or letter reminders, but reminders over the telephone may be expensive compared with alternative approaches. Reminders also worked whether it was from a private doctor's office, a medical center, or a public health department clinic. The studies in this review were from developed countries; and, it is therefore not clear whether reminders to patients would work in low- and middle-income countries.

BACKGROUND

In 1974 immunization rates in children worldwide were reported to be as low as 5% (GlobalAlliance 2001). A number of programs, such as the Expanded Programme on Immunization (EPI), launched by the World Health Assembly in 1974, helped to increase immunization rates throughout many parts of the world. By 1990 the vaccination coverage rate of children under five was 80%; this fell to 74% in 1999 (GlobalAlliance 2001). Global coverage of infants with DTP3 (3 doses of DTP) was estimated to be 79% in 2006, an increase of 59 percentage points since the 1980 level of 20% (WHO 2007). Yet, an estimated 26.3 million children did not receive DTP3 in 2006 (WHO 2007).

Access to immunizations, prevalence of vaccine-preventable diseases, and vaccination rates varies by geographic area or country. High levels of immunization coverage (86% to 92%) were achieved in the Americas, Europe, the Western Pacific, and the Eastern Mediterranean regions in 2006 (WHO 2007). In contrast, African countries suffer from a disproportionately high level of vaccine-preventable diseases (Arevshatian2007). The African Regional Strategic Plan of the Expanded Programme on Immunization established a goal for 80% of countries in Africa to reach 80% immunization coverage by 2005 (Arevshatian2007). This goal was not achieved; more than one-third of African Region districts did not reach 50% DTP3 coverage by the end of 2004 (Arevshatian2007). However, DTP3 coverage in Africa did increase from 54% in 2000 to 69% in 2004 (Arevshatian2007). The lowest vaccination coverage is found in sub-Saharan Africa (GlobalAlliance 2001).

Throughout the United States immunization rates for children and adults are rising, (CDC1997657; CDC1998547) but coverage levels have not reached national goals (CDC1999243). In 1998, coverage levels for children 19 to 35 months of age were at 79% for the 4:3:1:3:3 combined series of 4 DTP, 3 polio, 1 measles-containing vaccine, and 3 Hib; 87% for 3 hepatitis B, and 43% for varicella (CDCwebpage). In this same age group, coverage for the 4:3:1:3:3:1 series (which adds varicella vaccine to the 4:3:1:3:3 combined series) increased slightly from 76.1% in 2005 to 77.0% in 2006 (MMWR 2007). Coverage levels for adults are lower; in 1997 only 65% percent of adults over the age of 65 received the influenza vaccine, and only 45% had ever received pneumococcal vaccine (CDC1998797). During the 2005 to 2006 season, influenza vaccination rates were slightly higher (69.3%) (MMWR 2007a). Furthermore, immunization coverage levels are not evenly distributed, with low rates among impoverished populations, (CDC1997956) and some primary care practices (Massoudi 1999). Influenza immunization rates also vary by race or ethnicity, with reports of 71.9% among non-Hispanic whites compared with 58.3% among other racial or ethnic groups during the 2005-06 season (MMWR 2007a). As a result of low immunization rates, vaccine-preventable diseases still occur as evidenced by the measles epidemic during 1989-1991, (NVAC 1991) the large number of annual cases of varicella, pertussis, and hepatitis B, (CDC19981) and the more than 50,000 annual deaths in adults from influenza or pneumococcal infections (Fedsom 1994). There is also concern that incorporation of new vaccinations will be slow, as evidenced by the slow uptake of varicella vaccine (CDC1999829). Recent concerns about vaccine safety, (CDC199910; CDC1999996) may cause health care providers, patients, or parents to become more cautious about vaccinations.

In an era of increasing complexity of immunization schedules, rising expectations about the performance of primary care, and large demands on primary care physicians, it is important to understand and promote interventions that work in primary care settings. Published reviews have identified several promising strategies to improve immunization rates (Gyorkos 1994; Shea 1996; Udovic 1998; Task Force 1999; Shefer 1999). One strategy involves patient reminder or recall systems, which was recommended by the Task Force on Community Preventive Services (Task Force 1999) and the Standards for Immunization Practices (AdHocWorkingGroup).

Few primary care providers actually use reminder or recall systems, or both (Szilagyi 1994; Schaffer 1998). Because many patients cannot remember the recommended immunization schedule (Santoli 1998), the burden falls on primary care providers to ensure that their patients receive immunizations on a timely basis. Recently, in the U.S., the burden on the private sector has increased as more patients receive immunizations from their comprehensive primary care provider rather than at health department immunization clinics (Szilagyi 2000; Rodewald). While in some nations (such as the United Kingdom) (UK 2002) private providers administer the majority of vaccinations. In many other nations a variety of publicly funded clinics provide vaccinations. Nevertheless, the issue of determining who is eligible (i.e., the denominator), and how to vaccinate the entire population using either patient-oriented or provider-oriented strategies is a common one irrespective of type of setting or funding mechanism.

With experts recommending reminder or recall systems, or both, and individual studies demonstrating their effectiveness, why are these systems not utilized more frequently in primary care settings? Several factors may impede their incorporation. First, providers may not perceive that individual studies apply to their own practices. Pediatricians may not focus on studies involving elderly adults, and internists may not be aware of studies involving children. Some studies were performed in public health department clinics or academic teaching hospital clinics, and private providers may not believe those findings could be applied to their settings. Furthermore, some vaccinations are given only once, while others require multiple booster doses, making it more difficult to extrapolate findings from individual regimens to all vaccinations.

A second barrier is that recommendations about reminder or recall systems have not been very specific (Udovic 1998; Task Force

1999). Patient reminders can be delivered by a variety of methods (e.g. telephone, mail), and levels of intensity (e.g. single, or multiple reminders). The most useful recommendations are ones that apply to large numbers of providers but are specific enough to be applicable in real-world settings. A third barrier is that many primary care practices have lacked the computerized technology to track their patients' immunization status. However, recent advances in billing systems and computerized immunization registries (Linkins 1998) are making such technology attainable for a growing number of primary care practitioners.

Some countries, including a number in Europe, have made substantial progress toward developing computerized immunization registries (Paunio1991T89). Immunization registries offer the potential for becoming the backbone of patient reminder or recall systems by: (a) providing a denominator of potential vaccine recipients, (b) providing algorithms to determine who is eligible based on vaccination recommendations, and (c) providing means to send postcards, letters, or even telephone reminders.

Several common themes apply to both childhood and adult immunizations in all countries, including developing countries. First, immunizations are a major public health intervention by protecting not only those vaccinated but also the general population through prevention of spread of disease. Vaccine-preventable diseases are a major cause of mortality and morbidity throughout the world, due in large part to insufficiently high vaccination rates (WHO 2001). Second, while recommendations for specific vaccinations vary across nations, there are international efforts to improve immunization rates and reduce vaccine-preventable diseases (WHO 2002; Global02). Third, similar strategies are being considered across nations, including strategies to increase demand by focusing on patients (such as patient reminder and recall systems), strategies to focus on providers (such as reducing missed opportunities, or provider prompts), and system-wide strategies (such as financial interventions). Thus, the current review is widely applicable.

This is an update of an earlier Cochrane, last updated in 2005 (Jacobson Vann 2005).

OBJECTIVES

The study objectives were to:

- assess the overall effectiveness of patient reminder or recall systems, or both, in improving immunization rates;
- compare the effectiveness of different types of reminder or recall interventions (e.g. postcard, letter, telephone), or a combination of both reminder and recall.

METHODS

Criteria for considering studies for this review

Types of studies

Randomized controlled trials (RCT), controlled before-and-after studies (CBA), and interrupted time series studies (ITS) were included. Non-English language publications were excluded.

Types of participants

The study selection criteria for types of participants included health care personnel who deliver immunizations and children (birth to 18 years) or adults who receive immunizations in any setting (academic or non-academic, developed or developing countries).

Types of interventions

The study selection criteria for intervention type included patient reminder or recall interventions, or both, that either reminded patients of upcoming immunizations or immunization visits that were due (reminders) or were overdue (recall). Reminder and recall systems could be delivered by letter, postcard, telephone, autodialer (a computerized telephone dialer programmed to generate multiple telephone calls during a short time period), or in person (e.g. provider gives face-to-face reminder). Reminder and recall cues could also vary in their specificity (generic reminders or personal reminders that address issues specific to the patient), in their number (one-time or multiple reminders) and whether or not combined with other interventions such as provider reminders or outreach.

Types of outcome measures

Key outcome measures were immunization rates, or the proportion of the target population up-to-date on recommended immunizations. We accepted outcomes for either individual vaccinations or standard combinations of recommended vaccinations (e.g. all recommended vaccinations by a specific date or age).

Search methods for identification of studies

For the initial review, a search strategy was performed using the following bibliographic databases: MEDLINE (1966-1998), EMBASE, PsychINFO, Sociological Abstracts, and CAB Abstracts. All databases were searched from their date of inception. The search terms included the following, including text words (tw) or MeSH headings (mh): remind$ (tw), track$ (tw), autodial$ (tw), postcard$ (tw), mail$ (tw), recall$ (tw), telephone$ (tw), registry (tw), registries (mh and tw), reminder systems (mh), appointments & schedules (expanded mh), appointment$ (tw), information systems (expanded mh), computers (mh), immunization (expanded mh), immuniz$ (tw), immunization programs (mh), vaccination

(mh), vaccin$ (tw), innoculat$ (tw), prevention health services (mh), diphtheria (mh), tetanus (mh), whooping cough (mh), poliomyelitis (mh), polioviruses (mh), haemophilus (mh), influenza (mh), measles (mh), mumps (mh), rubella (mh), hepatitis b (mh), pneumococcal infections (mh), vaccines (expanded mh), tetanus toxoid (expanded mh), and diphtheria toxoid (expanded mh). The reference lists of all relevant articles and reviews were back searched for additional studies. Publications of abstracts, proceedings from scientific meetings, and files of study collaborators were also searched for references. In April 2001 the EPOC register was searched to update the review. For the 2005 review update, a search of the EPOC Register was performed on December 14, 2004 using the search terms: immuniz$, vaccin$, and innoculat$. The 2007 update involved a search of the EPOC register during May 2007 using the search terms: immunis*, immuniz*, vaccin*, and inoculat*. The EPOC search with supplemented on July 17, 2007 with a search of CINAHL using the terms immunization reminder, patient reminder, immunization recall, vaccine recall, vaccine reminder, and patient recall, and a search of PubMed using the term vaccine reminder. One study was identified through prior knowledge of this study. The searches were restricted to articles written or translated into English. Studies written in languages other than English may be reviewed in an update.

Data collection and analysis

For the initial review, two authors reviewed the lists of titles and abstracts, and used the inclusion criteria to mark potentially relevant articles for full review. For the updated reviews, one author reviewed the titles and abstracts to select relevant articles for full review. Each study that was selected as potentially relevant in the search process was read and abstracted independently by two reviewers (P.G.S. and J.C.J.V). Reviewers were not blinded to authors. Disagreements between reviewers on abstraction results were resolved by a formal reconciliation process to achieve concensus. Data abstraction utilized a checklist developed by the Cochrane Collaboration Effective Practice and Organization of Care Group (EPOC) (EPOC 2007). For each included study, information was collected on the method of randomization or assembly of control groups, blinding, characteristics of subjects, setting and nature of the interventions, and results. Numerous quality criteria were assessed for each study design (EPOC 2007).

For randomized controlled trials, which were the vast majority of included studies, assessment criteria included: concealment of allocation, proportion of participants followed up, blinded assessment of primary outcomes, documentation of baseline data, reliability of outcome measures, and protection of contamination between study groups. These are reported in the "Characteristics of Included Studies" table. As part of the 2005 update all new and previously included studies were reviewed for cluster allocation and unit of analysis errors. The review criteria in 2007 were unchanged from the 2005 update.

Quality Criteria -- Concealment of Allocation

Concealment of allocation, which refers to "how well the allocation to treatment group was concealed," was scored in the "Characteristics of Included Studies" table using the Review Manager scores of "A" through "D" (Higgins 2006). These scores are defined as:

A: "indicates adequate concealment of the allocation (for example, by telephone randomization, or use of consecutively numbered, sealed, opaque envelopes)."

B: "indicates uncertainty about whether the allocation was adequately concealed (for example, where the method of concealment is not known)."

C: "indicates that the allocation was definitely not adequately concealed (open random number lists, for example, or quasi-randomization such as alternate days, odd or even date of birth, or hospital number)."

D: "indicates the score was not assigned."

Quality Criteria -- Follow-up of allocation unit (professionals or patients)

Follow-up of professionals or patients or episodes of care was scored using the "A" through "D" scoring system as was used for "allocation concealment." A score of:

A: indicates that outcome measures were obtained from 80-100% of subjects randomized. Follow-up must be explicitly documented.

B: not clear; not specified in the paper.

C: not done, if outcomes were obtained for less than 80% of subjects randomized.

D: score was not assigned.

Quality Criteria -- Blinded Assessment of Primary Outcomes

Blinded assessment of primary outcomes was scored in the "Characteristics of Included Studies" table using the "A" through "D" scoring system. A score of:

A: indicates that the authors specifically documented that the primary outcome variables were assessed blindly or the outcome variables are objective measures.

B: not clear; not specified in the paper.

C: not done; if the outcomes were not assessed blindly.

D: score was not assigned.

Quality Criteria -- Reliable Primary Outcome Measure

The reliability of the primary outcome measure was scored in the "Characteristics of Included Studies" table using the "A" through "D" scoring system as listed above. A score of:

A: indicates two or more raters with at least 90% agreement or kappa greater than or equal to 0.8, or the outcomes is obtained from some automated system.

B: not clear; if reliability is not reported for outcome measures that are obtained by chart extraction or collected by an individual.

C: not done; if agreement is less than 90% or kappa is less than 0.8.

D: score was not assigned.

Quality Criteria -- Protection against contamination

Protection against contamination was scored in the "Characteristics of Included Studies" table using the "A" through "D" scoring system as listed above. A score of:

A: indicates the allocation was by community, institution or practice and it is unlikely that the control group received the intervention.

B: not clear; if professional were allocated within a clinic or practice and it is possible that communication between experimental and group professionals could have occurred.

C: not done; if it is likely that the control group received the intervention (e.g. cross-over trials or if patients rather than professionals were randomized).

D: score was not assigned.

Analysis Procedures

For the initial review EXCEL software (Excel 2005) was used to track the review process, manage the study-level and comparison-level data, compute odds ratios and 95% confidence levels for each study arm as a reliability check of results computed in Meta View and RevMan, sort studies by selected characteristics, record absolute changes in immunization rates (expressed as percentage point changes), and prepare funnel distribution displays of study-level data to assess for potential publication bias. Study-level data were analyzed using Meta View (RevMan 3.1), EXCEL software, and then RevMan. RevMan was used to compute odds ratios and 95% confidence intervals for individual RCT studies or study arms, assess heterogeneity of the study data, and compute summary odds ratios for RCT studies using the random effects models.

The Table of Comparisons was structured to examine study results (odds ratios) by type of patient reminder: (a) postcard; (b) letter; (c) person-to-person telephone call; (d) autodialer (computerized phone message system); (e) postcard and telephone call (combination); (f) tracking (patient reminder or recall) and outreach; (g) summary of all patient reminders; and (h) combinations of patient and provider reminders. Subcategories were set up within each intervention type listed above to perform subgroup analyses by major immunization category: (1) childhood influenza immunizations only; (2) routine immunizations delivered to preschool children; (3) adult influenza vaccinations only; and (4) other routine adult immunizations. In 2007, a new subcategory, adolescent immunizations, was added to two comparison categories, autodialer and patient reminder summary. This subcategory includes studies that focus exclusively on immunizations in adolescents age 11 to 19 years. Dichotomous data from included RCT studies only, and those not identified with potential cluster randomization limitations, were entered into Meta View and RevMan Analyses data tables for appropriate study arms, reminder type, and immunization category. In addition, data for these included RCT patient reminder or recall studies were re-entered into the patient reminder summary category to provide an overall measure of results. Data entered for each selected study arm includes: number of persons immunized (or up-to-date) in the intervention group; total number of persons in the intervention group; number of persons immunized (or up-to-date) in the control group; and total number of persons in the control group.

For studies with more than one patient reminder or recall intervention group with similar intervention types (e.g. two different types of postcards), intervention group data were combined. For RCT studies with outcomes reported in more than one immunization outcome category (based on the table of comparisons), multiple outcomes were reported at the individual reminder-type level, and data were combined for the summary comparison. If an RCT described a series of interventions (e.g. postcards sent at 1 month, 3 months and 5 months) with immunization outcomes measured after each intervention, the sample sizes for each cell (e.g. number of persons immunized in the intervention group) were averaged before being entered into RevMan for analysis.

In the initial review, the Peto odds ratios (fixed effects model) were computed in MetaView (RevMan 3.1) for the reminder types and immunization categories as listed above. The results were then tested for heterogeneity using the chi square distribution, with a 0.1 level of significance because of the low sensitivity of this test. The chi square tests were examined at the subgroup level as well as for the patient reminder groups to assess study heterogeneity. After testing for heterogeneity, the pooled measures were ultimately computed using the random effects model, including for the review update.

To assess whether possible publication bias exists, funnel distribution displays were created in EXCEL for the initial review. Sample size was plotted against both absolute measures of effect (percentage point changes in immunization rates) and relative measures (odds ratios).

RESULTS

Description of studies

Of the 398 studies that were reviewed for potential inclusion in this review, 97 were identified by literature searches, 17 by back-tracing, and 283 from the EPOC register (193 of these in 2007) and 1 from prior knowledge. Of the 122 studies that were fully reviewed, 47 met eligibility criteria and were included in the final review, including 5 new studies that were added in the 2005 update (Daley2004T513; Daley2004T515; Hull2002T511; LeBaron2004T512; Sansom2003T514) and 4 in the 2007 update (Irigoyen2006T702; Kempe2001T706; Kempe2005T707; Szilagyi2006T718) (see "References to Studies, Included Studies" and the table of "Characteristics of Included Studies"). Approximately two-thirds of excluded studies did not meet study design inclusion criteria.

I ntervention Type

Five types of patient reminder or recall interventions and combinations of some intervention types were reviewed. Each intervention type was a mechanism to inform patients or families of the need for a vaccination that is due or overdue. The methods include: letters to patients (22 studies) (Baker 1998T96; Brimberry1988T33; Campbell1994T87; Carter1986T104; Daley2004T513; Hogg1998T101; Kempe2005T707; Kemper1993T11; Lieu1997T69; Lieu1998T82; McDowell1986T46; Moran1992T16; Mullooly1987T67; Nexoe1997T92; Oeffinger1992T27; Ornstein1991T30; Rosser1991T61; Rosser1992T47; Satterthwaite1997T93; Siebers1985T36; Szilagyi1992T15; Young1980T63), postcards (9 studies) (Baker 1998T96; Buchner1987T34; Buffington1991T29; Campbell1994T87; Irigoyen2006T702; Larson1982T39; Puech1998T99; Spaulding1991T28; Tollestrup1991T18), person-to-person telephone calls (8 studies) (Brimberry1988T33; Ferson1995T57; Hull2002T511; Lukasik1987T85; McDowell1986T46; Rosser1991T61; Rosser1992T47; Sansom2003T514), autodialer (computerized phone messages) (5 studies) (LeBaron2004T512; Lieu1998T82; Linkins1994T49; Stehr-Green1993T10; Szilagyi2006T718), postcard and phone combination (4 studies) (Alto1994T54; Daley2004T515; Kempe2001T706; LeBaron1998T78), and tracking and outreach (2 studies) (Rodewald1999T95; Wood1998T105). Provider reminders, in combination with patient reminders, were also reviewed (5 RCT & 1 CBA) (Becker1989T23; Frame1994T52; Ornstein1991T30; Rodewald1999T95; Soljak1987T35). The total number of studies sorted by intervention type exceed the 47 included studies because many studies had more than one intervention arm.

Countries

Approximately three-fourths (36) of the included patient reminder or recall studies were performed in the United States (USA). The remaining 26% of studies were performed in Australia (2) (Ferson1995T57; Puech1998T99), Canada (5) (Hogg1998T101; Lukasik1987T85; McDowell1986T46; Rosser1991T61; Rosser1992T47), Denmark (1) (Nexoe1997T92), New Zealand (2) (Satterthwaite1997T93; Soljak1987T35), and United Kingdom (1) (Hull2002T511).

Participants

More than one-third of included studies (16) examined routine vaccinations of infants and children (Alto1994T54; Campbell1994T87; Daley2004T515; Ferson1995T57; Irigoyen2006T702; Kempe2001T706; LeBaron2004T512; Lieu1997T69; Lieu1998T82; Linkins1994T49; Oeffinger1992T27; Rodewald1999T95; Stehr-Green1993T10; Tollestrup1991T18; Wood1998T105; Young1980T63), and four studied influenza vaccinations in high-risk children and infants (Daley2004T513; Kempe2005T707; Kemper1993T11; Szilagyi1992T15). Less than half (20) (Baker 1998T96; Brimberry1988T33; Buchner1987T34; Buffington1991T29; Carter1986T104; Hogg1998T101; Hull2002T511; Larson1982T39; Lukasik1987T85; McDowell1986T46; Moran1992T16; Mullooly1987T67; Nexoe1997T92; Puech1998T99; Rosser1991T61; Satterthwaite1997T93; Siebers1985T36; Spaulding1991T28) of the studies assessed the effectiveness of patient reminder or recall interventions on adult influenza immunization rates for patients 65 years of age or older, those with chronic illnesses, or both. Six (Hogg1998T101; Ornstein1991T30; Rosser1991T61; Rosser1992T47; Sansom2003T514; Siebers1985T36) included studies assessed the effectiveness of patient reminder recall on any or all of adult tetanus, pneumococcal, or hepatitis B vaccine. 0ne new study examined the effect of patient reminders on adolescent immunizations (Szilagyi2006T718). The total number of studies described exceeds the 47 included studies as some studies examined more than one type of vaccine.

Settings

The patient reminder or recall studies were performed in diverse settings, ranging from urban to rural, and public to private to university-based. Examples of study settings are state health departments, health maintenance organizations (HMO), public health departments, urban teaching facilities, private practices, senior centers, rural practices, and schools.

Description of Excluded Studies

The "Characteristics of Excluded Studies" table briefly indicates the reason for exclusion from this review. Of the 75 studies in this table, 65% (49) of excluded articles did not meet the study design definitions for RCT, CBA or ITS. These studies either lacked a true control group, were descriptive or ecological studies, had insufficient data points to be considered ITS, were cost studies, or were reviews or editorials instead of studies. Three studies compared two interventions without a true control group. Thirteen studies examined the effectiveness of interventions that did not meet the review definition of the evaluated interventions, such as immunization stickers and patient-carried immunization cards, or individualized blended interventions to preclude evaluation of specific intervention types. Six studies used an outcome other than immunizations (e.g. preventive visits or services, cases of measles). One article reported a study of mammography with discussion of immunizations. The remaining three references were abstract only (Szilagyi2002T717; Wojciechowski1993T88) and an article that was later retracted (Abramson1995T66).

Risk of bias in included studies

Three (LeBaron1998T78; Margolis1992T17, Tollestrup1991T18) of the included studies used a CBA design; all of the remaining studies used a RCT design. One of the CBA studies (Tollestrup1991T18) had equivalent baseline immunization rates in the control and intervention study groups. Concealment of allocation, as defined in the EPOC Data Collection Checklist and as outlined above in Meth-

ods of the Review, was explicitly described in 36.4 percent (16 of 44) (Brimberry1988T33; Daley2004T513; Daley2004T515; Hogg1998T101; Hull2002T511; Irigoyen2006T702; Kemper1993T11; LeBaron1998T78; Lieu1997T69; Linkins1994T49; McDowell1986T46; Puech1998T99; Rodewald1999T95; Rosser1991T61; Rosser1992T47; Szilagyi2006T718) of the included RCT studies.

Allocation concealment was not clearly documented in 52.3 percent (23 of 44) (Alto1994T54; Baker 1998T96; Becker1989T23; Buchner1987T34; Buffington1991T29; Campbell1994T87; Carter1986T104; Ferson1995T57; Frame1994T52; Kempe2001T706; Kempe2005T707; Larson1982T39; Lieu1998T82; Moran1992T16; Mullooly1987T67; Ornstein1991T30; Satterthwaite1997T93; Siebers1985T36; Spaulding1991T28; Stehr-Green1993T10; Szilagyi1992T15; Wood1998T105; Young1980T63) of the included RCT studies.

Follow-up of the allocation unit (patient or provider), as specified by The Data Collection Checklist, was clearly documented in 54.3 percent (26 of 47) (Brimberry1988T33; Campbell1994T87, Carter1986T104; Hogg1998T101; Hull2002T511; Irigoyen2006T702; Kemper1993T11; Lieu1997T69; Lieu1998T82; Linkins1994T49; Lukasik1987T85; Margolis1992T17; McDowell1986T46; Moran1992T16; Nexoe1997T92; Ornstein1991T30; Puech1998T99; Rodewald1999T95; Rosser1992T47; Sansom2003T514; Siebers1985T36; Soljak1987T35; Spaulding1991T28; Szilagyi2006T718; Tollestrup1991T18; Wood1998T105) of the included studies, "not clear" in 31.9 percent (15 of 47, (Alto1994T54; Baker 1998T96; Becker1989T23; Buffington1991T29; Daley2004T513; Daley2004T515; Frame1994T52; LeBaron1998T78; LeBaron2004T512; Mullooly1987T67; Oeffinger1992T27; Satterthwaite1997T93; Szilagyi1992T15) of the studies, and not done in 12.8 percent (6 of 47) (Buchner1987T34; Ferson1995T57; Larson1982T39; Rosser1991T61; Stehr-Green1993T10; Young1980T63).

Almost half (22 of 47; 46.8%) of the included studies (Becker1989T23; Brimberry1988T33; Buchner1987T34; Carter1986T104; Hogg1998T101; Hull2002T511; Kempe2005T707; Kemper1993T11; LeBaron1998T78; Lieu1997T69; Lieu1998T82; Linkins1994T49; McDowell1986T46; Ornstein1991T30; Puech1998T99; Rodewald1999T95; Rosser1991T61; Rosser1992T47; Siebers1985T36; Soljak1987T35; Szilagyi1992T15; Szilagyi2006T718) clearly documented blinded assessment of the primary outcome(s). This was not clearly documented in 46.8 percent (22 of 47) of included studies (Alto1994T54; Baker 1998T96; Campbell1994T87; Daley2004T513; Daley2004T515; Ferson1995T57; Frame1994T52; Irigoyen2006T702; Kempe2001T706; Larson1982T39; Lukasik1987T85; Moran1992T16; Mullooly1987T67; Nexoe1997T92; Oeffinger1992T27; Sansom2003T514; Satterthwaite1997T93; Spaulding1991T28; Stehr-Green1993T10; Tollestrup1991T18; Wood1998T105; Young1980T63).

Fourteen (29.8%) included studies (Baker 1998T96; Carter1986T104, Hogg1998T101; Kempe2001T706; Lieu1997T69; Lieu1998T82; Linkins1994T49; McDowell1986T46; Moran1992T16; Puech1998T99; Rosser1991T61; Soljak1987T35; Spaulding1991T28; Szilagyi2006T718) clearly documented the reliability of the primary outcome measure. Protection against contamination (of the study groups) was present in only six studies (Buffington1991T29; LeBaron1998T78; Linkins1994T49; Margolis1992T17; Rosser1992T47; Tollestrup1991T18) or 12.8% of the included studies using the criteria in The Data Collection Checklist because most studies of patient reminder or recall systems allocated patients to study groups rather than allocating clinical settings or practices to study groups.

Effects of interventions

Overall Patient Reminder Results

Patients receiving the patient reminder or recall interventions were more likely to have been immunized or up-to-date with immunizations compared with control subjects, with an odds ratio (OR) of 1.57, using the pooled random effects model (95% CI: 1.41, 1.75). There were ten studies (Buffington1991T29; Frame1994T52; Lukasik1987T85; McDowell1986T46; Ornstein1991T30; Puech1998T99; Rodewald1999T95; Rosser1991T61; Rosser1992T47; Spaulding1991T28) not included in the meta-analysis because of potential unit of analysis errors but were included in the review. Together, these ten studies have a median odds ratio of 3.37. An additional three studies (LeBaron1998T78; Margolis1992T17; Tollestrup1991T18) are also analyzed separately because they are CBA studies; together, the three CBAs have a median odds ratio of 1.57.

Routine Childhood Immunizations

In patients receiving routine childhood vaccinations, reminder or recall interventions increased the likelihood of being vaccinated or up-to-date with immunizations with a pooled random effects OR of 1.47 (95% CI: 1.28, 1.68). Two studies (Daley2004T515; LeBaron2004T512) and two comparisons were added to this set of analyses for the 2005 updated review and two (Irigoyen2006T702; Kempe2001T706) to the updated review in 2007. Both new studies in 2007 demonstrated higher rates of age-appropriate immunizations for patients in the patient intervention arms, compared with controls, with improvements not being statistically significant. In one new study both the intervention and comparison groups received provider prompts (Kempe2001T706). One study reviewed in 2005 (Daley2004T515) examined age-appropriate immunization rates after a very brief two-month study period, which may account for the post-intervention one percentage point difference between study groups. The magnitude of the effects in

the included comparisons are in the range of 2 percentage point decrease to 34 percentage point increase in immunization rates. Only one eligible RCT study was excluded for a potential unit of analysis error (Rodewald1999T95); the odds ratio for this study was 6.79 (95% CI: 4.56, 10.11). One CBA study, which demonstrated a positive effect in this population (Tollestrup1991T18), had an Odds Ratio of 4.11 (95% CI: 2.18, 7.76). The other CBA study (LeBaron1998T78) demonstrated a non-significant effect, but the baseline rates between the study arms were substantially different.

Childhood Influenza Immunizations

The three originally included studies of childhood influenza immunizations demonstrated 17 to 26 percentage point improvements in influenza immunization rates for patient reminder or recall intervention groups over very low baseline rates of controls, with a pooled random effects odds ratio of 2.87 (95% CI: 1.65, 4.98). The third study (Daley2004T513), added in the 2005 updated review, showed the least effect and decreased the pooled random effects odds ratio in that update. In 2007 a fourth study of childhood influenza immunizations was added. This study (Kempe2005T707) examined the effect of patient reminder and recall letters on the receipt of influenza vaccination for healthy 6- to 23- month old children, in contrast to the previous studies which targeted children with high risk conditions. The Odds Ratio of 1.20 (1.07, 1.34) in the Kempe study (Kempe2005T707) reduced the overall effect of patient reminders and recall on childhood influenza immunizations to an Odds Ratio of 2.18 (95% CI: 1.29, 3.70). This new study (Kempe2005T707) reported several limitations, including a vaccine shortage, a pandemic with extensive media coverage, and the use of a telephone survey prior to the intervention to assess attitudes and intentions regarding influenza vaccination.

Adult Pneumococcal, Tetanus, Hepatitis B Immunizations ("other adult")

All six included studies and 12 comparisons of adult pneumococcal, tetanus or Hepatitis B immunizations demonstrated higher immunization rates in the patient reminder or recall intervention groups compared with controls. Vaccination increases ranged from 1.8 to 27.4 percentage points, with five comparisons showing at least 20 percentage point increases. In all but one study (Hogg1998T101) (and eight of 12 comparisons) the improvements were statistically significant. The pooled random effects OR for the three studies of adult pneumococcal, tetanus, or Hepatitis B vaccinations without unit of analysis errors (Hogg1998T101; Sansom2003T514; Siebers1985T36) is 2.19 (95% CI: 1.21, 3.99). The above results include one study (with one comparison) which was added to this subgroup for the 2005 updated review. This study (Sansom2003T514) demonstrated a statistically significant increase in Hepatitis B vaccinations for the intervention group, compared with controls. No new studies were added to this subanalysis in the 2007 update. There were three eligible studies (Ornstein1991T30; Rosser1991T61; Rosser1992T47) with potential unit of analysis errors which were not included in the analysis; the median odds ratio for these three studies was 13.32.

Adult Influenza Immunizations

Among the 20 included studies of adult influenza immunizations, two studied patient reminders in combination with provider reminders (Becker1989T23; Margolis1992T17), and one study (Carter1986T104) used a less-intense patient reminder (standard letter) as the comparison. Patient and provider reminder combinations are discussed under "Effectiveness of Different Types of Reminder or Recall Systems." The changes in vaccination rates in the patient reminder or recall groups ranged from 8.5 percentage point decrease to 47 percentage point increase compared with the controls, with half of the comparisons exceeding a 15 percentage point increase. Of the 18 studies of patient reminders only, data from six were not entered in RevMan analysis because of unit of analysis errors. The pooled random effects summary OR for the remaining group of 12 RCT studies (Baker 1998T96; Brimberry1988T33; Buchner1987T34; Carter1986T104; Hogg1998T101; Hull2002T511; Larson1982T39; Moran1992T16; Mullooly1987T67; Nexoe1997T92; Satterthwaite1997T93; Siebers1985T36) without unit of analysis errors was 1.66 (95% CI: 1.31, 2.09). One study (Hull2002T511) of telephone reminders with modest relative increases in influenza vaccinations (OR = 1.3) was added as part of the 2005 review update. This additional study, and the omission of data from studies with unit of allocation errors, resulted in a decrease in the pooled random effects odds ratio for adult influenza vaccinations from the initial review. No additional studies were added to these subanalyses in the 2007 update. There were six eligible studies with potential unit of analysis errors. The median odds rations for these six studies (Buffington1991T29; Lukasik1987T85; McDowell1986T46; Puech1998T99; Rosser1991T61; Spaulding1991T28) was 3.08. One study (Hull2002T511) had a potential unit of analysis error, but the authors reported an adjusted odds ration as well. The adjusted OR is very close to unadjusted, and the impact using a generic inverse variance method of analysis showed minimal effect on the overall odds ratio.

Adolescent Immunizations

One study of urban adolescent immunizations (Hepatitis B and Td), added in the 2007 update, was not successful with significantly increasing immunizations using autodialer (OR = 1.14, 95% CI = 0.98, 1.31) (Szilagyi2006T718). This study faced challenges of unstable telephone numbers.

Effectiveness of Different Types of Reminder or Recall Systems

We examined the pooled results for randomized controlled trials to compare the effectiveness of different types of reminder and recall systems for routine vaccination of preschool children, child influenza vaccination, adult influenza vaccination, other adult vaccines, and adolescent vaccines. The Table of Comparisons was set up to facilitate these sub-analyses. All six types of reminder or recall systems appeared to improve immunization rates com-

pared to controls, with five of six types demonstrating statistically signficant improvements. Person-to-person telephone reminders were the most effective single approach (OR = 1.92, 95% CI: 1.20, 3.07). Letter reminders were represented by 20 comparisons in the analysis, and were close to the level of effectiveness of phone reminders, with a pooled random effects odds ratio of 1.79 (95% CI: 1.50, 2.15). The effectiveness of postcard, autodialer, and postcard combined with telephone reminders were equivalent in the 2007 update, when excluding adolescent vaccines. The effectiveness of autodialer decreased with the addition of one urban adolescent study (Szilagyi2006T718). Six comparisons from RCT studies were included in the analysis of postcard reminders, with an odds ratio of 1.44 (95% CI: 1.09, 1.89). One CBA study (Tollestrup1991T18) of postcards also demonstrated significant effects with an odds ratio of 4.11. The pooled random effects odds ratios for other statistically significant reminder and recall systems follow: autodialer (OR = 1.29; 95% CI: 1.09, 1.53), and postcard and telephone call combined (OR = 1.45, 95% CI: 1.11, 1.89). Patient reminder and recall in combination with outreach is the least effective approach in this analysis based on the non-significant odds ratio of 1.37 (95% CI: 0.98, 1.98); however, this subanalysis included only two comparisons. This result for patient reminder and recall with outcomes in the updated review (in 2005) is in stark contrast to the initial review where this intervention type was second in effectiveness to phone reminders. When results of four comparisons of patient reminder recall interventions combined with provider reminder were pooled, the effectiveness exceeded those of patient reminder or recall systems alone (OR = 3.65; 95% CI: 1.54, 8.67). This result did not change from 2005 to 2007. There was also one CBA study (Margolis1992T17) which showed a positive effect of a combined patient and provider intervention with an odds ratio of 1.32.

Heterogeneity

In the initial review, the pooled odds ratios were first computed for each of the comparisons within Metaview using the fixed effects model. Within Metaview, a chi square test was available to test for statistical diversity or heterogeneity of the treatment effects that exists among the different sets of data. This chi square test was employed using a 10 percent one-tailed level of significance because of the low sensitivity of this test. The chi square tests showed heterogeneity in the studies. This finding was anticipated because of the wide range of study methods and procedures employed, intervention types, settings, immunization types, and other study characteristics. It is also possible that some of the heterogeneity can be attributed to the variable baselines levels in immunization rates. After performing tests for heterogeneity, the results for the initial review were re-calculated using the random effects model. All results in the updated reviews in 2005 and 2007 were performed using the random effect model.

Costs of Patient Reminder or Recall Systems

Sixteen studies reported basic cost data, including eight pediatric studies (Stehr-Green1993T10; Linkins1994T49; Young1980T63; Lieu1997T69; Lieu1998T82; Campbell1994T87; Rodewald1999T95; Wood1998T105) and six studies of adults (Buchner1987T34; McDowell1986T46; Rosser1992T47; Nexoe1997T92; Baker 1998T96; Hull2002T511). Eight studies estimated cost-effectiveness of reminder and recall systems (McDowell1986T46; Rosser1992T47; Lieu1998T82; Lieu1997T69; Young1980T63; Rodewald1999T95; Young1980T63; LeBaron2004T512). Costs varied widely across studies, due to variability in methods of calculating costs and items included in analyses (such as existing staff or computer programming); different types of reminders used, with telephone reminders being more costly than letter or postcard reminders; different levels of intensity of interventions, from single postcard reminders to repeated reminders plus home visits; and, different study time periods. As a result of the limited cost data reported and variations in the methods the cost information is of limited use.

DISCUSSION

The findings from this systematic review of the literature support the general recommendation (Udovic 1998; Task Force 1999; Shefer 1999; AdHocWorkingGroup) that primary care providers should consider implementing patient reminder and recall systems to improve immunization coverage levels of their practices. However, all included studies were performed in developed country health care systems; therefore, these findings may not be generalizable to low and middle income countries, given the variations in primary care organization and fewer resources in primary care. We found that reminder and recall systems were effective for both children and adults, in all types of medical settings including private practices, academic medical centers, and public health department clinics, and for universally recommended vaccinations such as routine childhood vaccinations as well as targeted vaccinations such as influenza vaccine. Patient reminders were not, however, effective in one new study of adolescent immunizations in an urban setting. In addition, all types of patient reminder and recall were found to be effective, with increases in immunization rates tending to be on the order of 5-20 percentage points. Telephone reminders were most effective, while letter reminders were somewhat more effective than postcard reminders among mailed reminders. More intensive reminder and recall, such as those using multiple reminders, appeared to be more effective than single reminders.

This study has several potential limitations. First, the scope of the review was limited to studies published in English. At least one study has found that randomized controlled trials published in English were more likely to have positive findings than studies published in German journals (Egger 1997). However, such language bias was not noted in another study (Heidenreich 1999).

A second potential limitation involves publication bias, because the majority of studies were located from EPOC, MEDLINE or references from other studies. Because publication bias typically results in failure to publish studies with negative or null findings, (Chalmers 1990; Easterbrook 1991; Dickerson 1992) it is possible that our findings of positive outcomes in the majority of reviewed studies is partly affected by publication bias and that the impact of reminder and recall is lower than noted in this review. We attempted to minimize publication bias in the initial review by searching the files of the investigators and immunization experts, searching references of published reviews for abstracts, and reviewing abstracts or proceedings of major scientific meetings. In addition, a funnel plot analysis in the initial review examining the relationship between effect size and sample size did not find more precise studies clustered around null results, thereby increasing the plausibility of the positive findings.

A third potential limitation involves aspects of the systematic review process. We grouped studies according to key characteristics of either the patient population or the intervention. We defined these groups a priori, and they represent standard groupings used in other studies. However, it is possible that where differences were noted by group, factors other than the intervention might have accounted for these differences. Limitations of the standard Cochrane review criteria are published elsewhere (Jadad 1998).

A fourth limitation resulted from omitting studies with potential unit of analysis errors from from meta-analysis. Twelve generally well-designed studies included in the initial review, were omitted from the analyses in the 2005 and 2007 updates because of potential unit of analysis errors. This loss of information tended to reduce the strength of the measures of effect.

Our method of pooling data has limitations, particularly in light of heterogeneity of some of the data which is often present in meta-analyses (Gottlieb 1982; Thompson 1991). Because these reminder or recall studies were performed for a variety of populations, using different interventions, in multiple settings, and across 3 decades (in the initial review), it is not surprising that there is between-study heterogeneity in the results. Because of this heterogeneity, we performed a qualitative analysis of study characteristics that might explain differences in findings among the eight studies that had negative findings; and although it was easy to find explanations for the negative findings in each study, we did not note consistent trends. We used random effects analyses which had consistently more "conservative" (wider confidence intervals) results than fixed effects models. In one subgroup, a single study by Baker (Baker 1998T96) had more than 24,000 subjects and small but significant effects of reminder or recall, while most of the other studies in that group had clinically larger positive effects of reminder or recall. The large sample size and small effect of that one study resulted in heterogeneity within this subgroup, but also resulted in a conservative effect on the pooled results by reducing the overall impact of reminder or recall.

One final limitation pertains to the inevitable lack of perfection in any study selected for inclusion in this review. Individual study results may have been biased as a result of: vaccination status is collected from only one care delivery location (Baker 1998T96; Moran1992T16); the control group includes a less intense intervention, thereby potentially diminishing the observed effect (Carter1986T104; Ferson1995T57; LeBaron2004T512); subjects are lost to follow-up (Ferson1995T57; Larson1982T39; Stehr-Green1993T10); extensive media campaigns may contaminate the study groups (Puech1998T99; Kempe2005T707), and vaccine shortages (Kempe2005T707). Some flaws in study design are not very amenable to change, such as external media campaigns. However, practices can work to optimize the effects of patient reminder and recall systems by improving internal operational systems and learning from those programs with the greatest successes.

AUTHORS' CONCLUSIONS

Implications for practice

In all settings that were evaluated, patient reminder and recall systems appear to be effective for improving immunization rates. As such, methods to incorporate reminder and recall systems into practices should have a positive impact on vaccine-preventable diseases. Different types of reminder and recall systems can be tailored to suit specific provider or practice needs. While person-to-person telephone reminders are most effective, they are also generally more costly than other methods, and have not been studied extensively in children except for the use of autodialers, which were found to have smaller but positive effects. Practical issues relevant to choices of reminder and recall systems include: characteristics of current computer systems, staffing, perceived accuracy of patient telephone numbers or addresses, availability of computer programmers, and estimated patient responsiveness to different types of reminders. Because these factors vary widely across nations or geographic regions, immunization leaders will want to interpret the findings in this review with respect to their own setting. For example, settings with widely used computerized immunization registries could adopt postcard reminders sent by the registries. Practitioners today can tailor their own billing systems to function as reminder and recall systems for simple procedures, such as selecting all patients over 65 years of age for reminders about influenza or pneumococcal vaccination. Many billing systems have recently incorporated separate modules that can track immunization status.

A critical issue involves the complexity of "rules" required for a reminder or recall system. The simplest scenario involves elderly adults, because no special immunization algorithm is needed and eligible patients can be selected by birth dates. A slightly more complex scenario involves "flagging" patients with chronic prob-

lems, such as asthma or heart disease, that would require influenza or pneumococcal (for adults) vaccination. More sophisticated algorithms are required to track prior immunization status, particularly for the complicated pediatric immunization schedule. A very promising route involves practitioners linking with computerized immunization registries that are being developed throughout the U.S. (CDCP1998; NVAC 1999; USDHHS2000), already available in several nations (Canadian 1998), and being discussed in various forms in developing nations. These registries already contain the necessary algorithms to assess up-to-date status of children, and could be modified to deliver patient reminders. Finally, databases of managed care organizations can be modified to become reminder and recall systems. For practitioners, the usefulness of such databases depends on the proportion of a practice's patients covered by the managed care plan and the accuracy of the database information.

Overall, the technology exists, in the developed world, to incorporate patient reminder and recall into routine primary care practice. There are additional benefits to the patient and practice, beyond improving immunization rates. Studies have shown that patients behind with immunizations are also behind in other measures of preventive care, (Fairbrother 1996; Rodewald 1995) and that reminder or recall systems targeting immunizations can also have "spillover effects" to improve other aspects of preventive care, (Rodewald 1999) if they are used within primary care practices. Second, in fee-for-service settings, patient reminder and recall systems can increase revenues by increasing visits.

This review focused on patient reminder and recall systems in settings in which the potential recipients are followed by health care providers over time. This is the case throughout the developed countries, in which many or most children and adults have primary health care providers whom they see on a regular or as-needed basis. The providers could be public or private, physicians or other health care experts, generalists or more specialized providers (such as pediatricians in the US). The cornerstone is that there is a population of potential recipients who would need annual influenza vaccinations (in the case of adults or children with chronic respiratory diseases), or periodic vaccinations on some schedule (in the case of children). In many developing countries or regions, such a situation does not exist; and although health care providers do serve patients, there is little ability to determine the population of eligible vaccine recipients. In these countries, the concept of "vaccination days" or vaccination programs have been employed (WHO 2001; WHO 2002; Global02; UNICEF1996). These strategies involve massive vaccination programs during single days or weeks, in which entire populations are vaccinated. Much of the world success in eradicating polio is due to such programs (WHO 2003), as well as to more "traditional" methods of vaccinating eligible populations within public or private health care systems. However, this review has not evaluated the use of "vaccination day" strategies. Obviously, patient reminder and recall programs are not likely to be applicable in those settings that rely on vaccination days or single, short-term vaccination programs. However, in virtually all settings in which patient reminder and recall interventions were rigorously evaluated (and all these settings were ones in which patients were connected with a health care system), the reminder and recall systems were found to be effective in improving immunization rates.

The use of patient reminder and recall systems provides the primary care practitioner with real-life experience at practicing population-based care, by improving the care for the entire population served by the practice (Halpern 2000). Although medicine is traditionally taught and practiced one patient at a time, and preventive services such as immunizations are delivered to individual patients, the measures of success (such as immunization rates) are population-based. Such population-based primary care, while not easy to do in a busy practice, has the potential to improve the quality of care and performance of primary care providers (Halpern 2000; OConnor 1998; Rivo1998).

Implications for research

This study also has implications for research. With the plethora of studies showing that patient reminder and recall systems improve immunization rates in all types of settings, future researchers should consider not simply repeating prior studies but rather building on them. For example, more research is needed on defining the most cost-effective types of reminder and recall interventions. There was only one study reviewed on adolescent immunization delivery in an urban setting; this study did not demonstrate significant improvement with use of autodialer reminders. With the rising importance of adolescent immunizations and multiple settings that adolescents receive care, additional studies of adolescents would be useful. Further, the rapid implementation of computerized immunization registries presents opportunities for research in implementing, on a community-wide basis, reminder and recall interventions that appear to be effective in single practice settings. In addition, managed care plans have databases that could be used as the backbone of reminder and recall interventions; studies incorporating such linkages would be helpful. Studies about "fine-tuning" patient reminder and recall interventions would be helpful, such as investigations of the degree to which different combinations improve outcomes, or the degree to which combinations of patient reminder and recall and other types of interventions improve outcomes. Finally, because the majority of reviewed studies of patient reminder and recall interventions found positive effects, any studies that do not find improved immunizations should carefully investigate the reasons for lack of improvement. Such detailed investigations may uncover important barriers to care delivery that are likely to be useful in better understanding how to improve services for patients.

ACKNOWLEDGEMENTS

We wish to acknowledge the CDC for providing funding for the research (grant # 5-29029) related to the initial review, Department of Health (England) Cochrane Review Update Incentive Scheme for their funding for the 2005 update, Sharon Humiston for her help and wisdom, and Clay Bordley, Peter Margolis, Ron Kraus, Page Abrahamson, Ann Chelminski and Lance Rodewald for their contributions made during the initial review. We also wish to acknowledge Alain Mayhew and Jessie McGowan for their administrative assistance and guidance provided during the 2005 updated review, Doug Salzwedel for assistance in 2007, and Lisa Bero and Jeremy Grimshaw for editorial assistance and guidance with the review process.

REFERENCES

References to studies included in this review

Alto1994T54 *{published data only}*
Alto W, Fury D, Condo A, Doran M, Aduddell M. Improving the immunization coverage of children less than 7 years old in a family practice residency. *Journal of the American Board of Family Medicine* 1994;**7**(6):472–477.

Baker 1998T96 *{published data only}*
Baker A, McCarthy B, Gurley V, Yood M. Influenza immunization in a managed care organization. *Journal of General Internal Medicine* 1998;**13**:469–475.

Becker1989T23 *{published data only}*
Becker D, Gomez E, Kaiser D, Yoshihasi A, Hodge R. Improving preventive care at a medical clinic: how can the patient help?. *American Journal of Preventive Medicine* 1989; **5**(6):353–359.

Brimberry1988T33 *{published data only}*
Brimberry R. Vaccination of high-risk patients for influenza. A comparison of telephone and mail reminder methods. *The Journal of Family Practice* 1988;**26**(4):397–400.

Buchner1987T34 *{published data only}*
Buchner D, Larson E, White R. Influenza vaccination in community elderly. A controlled trial of postcard reminders. *Journal of the American Geriatrics Society* 1987; **35**(8):755–760.

Buffington1991T29 *{published data only}*
Buffington J, Bell K, LaForce F. A target-based model for increasing influenza immunizations in private practice. Genesee Hospital Medical Staff. *Journal of General Internal Medicine* 1991;**6**(3):204–209.

Campbell1994T87 *{published data only}*
Campbell JR, Szilagyi PG, Rodewald LE, Doane C, Roghmann KJ. Patient-specific reminder letters and pediatric well-child-care show rates. *Clinical Pediatrics* 1994;**33**(5):268–72.

Carter1986T104 *{published data only}*
Carter W, Beach L, Inui T. The flu shot study: using multiattribute utility theory to design a vaccination intervention. *Organizational Behavior and Human Decision Processes* 1986;**38**:378–391.

Daley2004T513 *{published data only}*
Daley MF, Barrow J, Pearson K, Crane LA, Gao D, Stevenson JM, Berman S, Kempe A. Identification and recall of children with chronic medical conditions for influenza vaccination. *Pediatrics* 2004;**113**(1):e26–e33.

Daley2004T515 *{published data only}*
Daley MF, Steiner JF, Kempe A, Beaty BL, Pearson KA, Jones JS, Lowery NE, Berman S. Quality improvement in immunization delivery following an unsuccessful immunization recall. *Ambulatory Pediatrics* 2004;**4**(3): 217–223.

Ferson1995T57 *{published data only}*
Ferson M, Fitzsimmons G, Christie D, Woollett H. School health nurse interventions to increase immunisation uptake in school entrants. *Public Health* 1995;**109**(1):25–29.

Frame1994T52 *{published data only}*
Frame P, Zimmer J, Werth P, Hall W, Eberly S. Computer-based vs manual health maintenance tracking. A controlled trial. *Archives of Family Medicine* 1994;**3**(7):581–588.

Hogg1998T101 *{published data only}*
Hogg W, Bass M, Calonge N, Crouch H, Satenstein G. Randomized controlled study of customized preventive medicine reminder letters in a community practice. *Canadian Family Physician* 1998;**44**:81–88.

Hull2002T511 *{published data only}*
Hull S, Hagdrup N, Hart B, Griffiths C, Hennessy E. Boosting uptake of influenza immunisation: a randomised controlled trial of telephone appointing in general practice. *The British Journal of General Practice* 2002;**52**(482): 712–716.

Irigoyen2006T702 *{published data only}*
Irigoyen MM, Findley S, Wang D, Chen S, Chimkin F, Pena O, Mendonca E. Challenges and successes of immunization registry reminders at inner-city practices. *Ambulatory Pediatrics* 2006;**6**(2):100–104.

Kempe2001T706 *{published data only}*
Kempe A, Lowery E, Pearson KA, Renfrew BL, Jones JS, Steiner JF, Berman S. Immunization recall: effectiveness and barriers to success in an urban teaching clinic. *The Journal of Pediatrics* 2001;**139**(5):630–635.

Kempe2005T707 *{published data only}*
Kempe A, Daley MF, Barrow J, Allred N, Hester N, Beaty BL, Crane LA, Pearson K, Berman S. Implementation of universal influenza recommendations for healthy young children: results of a randomized, controlled trial with registry-based recall. *Pediatrics* 2005;**115**(1):146–154.

Kemper1993T11 *{published data only}*
Kemper K, Goldberg H. Do computer-generated reminder letters improve the rate of influenza immunization in an urban pediatric clinic?. *American Journal of Diseases of Children* 1993;**147**(7):717–718.

Larson1982T39 *{published data only}*
Larson E, Bergman J, Heidrich F, Alvin B, Schneeweiss R. Do postcard reminders improve influenza compliance? A prospective trial of different postcard "cues". *Medical Care* 1982;**20**(6):639–648.

LeBaron1998T78 *{published data only}*
LeBaron CW, Starnes D, Dini EF, Chambliss JW, Chaney M. The impact of interventions by a community-based organization on inner-city vaccination coverage. *Archives of Pediatrics & Adolescent Medicine* 1998;**152**:327–332.

LeBaron2004T512 *{published data only}*
LeBaron CW, Starnes DM, Rask KJ. The impact of reminder-recall interventions on low vaccination coverage in an inner-city population. *Archives of Pediatrics & Adolescent Medicine* 2004;**158**(3):255–261.

Lieu1997T69 *{published data only}*
Lieu T, Black S, Ray P, Schwalbe J, Lewis E, Lavetter A, Morozumi P, Shinefield H. Computer-generated recall letters for underimmunized children: how cost effective?. *Pediatric Infectious Disease Journal* 1997;**16**(1):28–33.

Lieu1998T82 *{published data only}*
Lieu TA, Capra AM, Makol J, Black SB, Shinefield HR. Effectiveness and cost-effectiveness of letters, automated telephone messages, or both for underimmunized children in a health maintenance organization. *Pediatrics* 1998;**101**(4):e3–13.

Linkins1994T49 *{published data only}*
Linkins R, Dini E, Watson G, Patriarca P. A randomized trial of the effectiveness of computer-generated telephone messages in increasing immunization visits among preschool children. *Archives of Pediatrics & Adolescent Medicine* 1994;**148**(9):908–914.

Lukasik1987T85 *{published data only}*
Lukasik MH, Pratt G. The telephone: an overlooked technology for prevention in family medicine. *Canadian Family Physician* 1987;**33**:1997–2001.

Margolis1992T17 *{published data only}*
Margolis K, Nichol K, Wuorenma J, VonSternberg T. Exporting a successful influenza vaccination program from a teaching hospital to a community outpatient setting. *Journal of the American Geriatrics Society* 1992;**40**(10):1021–1023.

McDowell1986T46 *{published data only}*
McDowell I, Newell C, Rosser W. Comparison of three methods of recalling patients for influenza vaccination. *CMAJ* 1986;**146**(6):911–917.

Moran1992T16 *{published data only}*
Moran W, Nelson K, Wofford J, Velez R. Computer-generated mailed reminders for influenza immunization: a clinical trial. *Journal of General Internal Medicine* 1992;**7**(5):535–537.

Mullooly1987T67 *{published data only}*
Mullooly. Increasing influenza vaccination among high-risk elderly: A randomized controlled trial of a mail cue in an HMO setting. *American Journal of Public Health* 1987;**77**(5):626–627.

Nexoe1997T92 *{published data only}*
Nexoe J, Kragstrup J, Ronne T. Impact of postal invitations and user fee on influenza vaccination rates among the elderly. *Scandinavian Journal of Primary Health Care* 1997;**15**:109–112.

Oeffinger1992T27 *{published data only}*
Oeffinger K, Roaten S, Hitchcock M, Oeffinger P. The effect of patient education on pediatric immunization rates. *The Journal of Family Practice* 1992;**35**(3):288–293.

Ornstein1991T30 *{published data only}*
Ornstein S, Garr D, Jenkins R, Rust P, Arnon A. Computer-generated physician and patient reminders. Tools to improve population adherence to selected preventive services. *The Journal of Family Practice* 1991;**32**(1):82–90.

Puech1998T99 *{published data only}*
Puech M, Ward J, Lajoie V. Postcard reminders from GPs for influenza vaccine: are they more effective than an ad hoc approach?. *Australian and New Zealand Journal of Public Health* 1998;**22**(2):254–256.

Rodewald1999T95 *{published data only}*
Rodewald L, Szilagyi P, Humiston S, Barth R, Kraus R, Raubertas R. A randomized study of tracking with outreach and provider prompting to improve immunization coverage and primary care. *Pediatrics* 1999;**103**(1):31–38.

Rosser1991T61 *{published data only}*
Rosser W, McDowell I, Newell C. Use of reminders for preventive procedures in family medicine. *CMAJ* 1991;**145**(7):807–814.

Rosser1992T47 *{published data only}*
Rosser W, Hutchison B, McDowell I, Newell C. Use of reminders to increase compliance with tetanus booster vaccination. *CMAJ* 1992;**146**(6):911–917.

Sansom2003T514 *{published data only}*
Sansom S, Rudy E, Strine T, Douglas W. Hepatitis A and B vaccination in a sexually transmitted disease clinic for men who have sex with men. *Sexually Transmitted Diseases* 2003; **30**(9):685–688.

Satterthwaite1997T93 *{published data only}*
Satterthwaite P. A randomised intervention study to examine the effect on immunisation coverage of making influenza vaccine available at no cost. *The New Zealand Medical Journal* 1997;**110**:58–60.

Siebers1985T36 *{published data only}*
Siebers M, Hunt V. Increasing the pneumococcal vaccination rate of elderly patients in a general internal medicine clinic. *Journal of the American Geriatrics Society* 1985;**33**(3):175–178.

Soljak1987T35 *{published data only}*
Soljak M, Handford S. Early results from the Northland immunisation register. *The New Zealand Medical Journal* 1987;**100**(822):244–246.

Spaulding1991T28 *{published data only}*
Spaulding S, Kugler J. Influenza immunization: the impact of notifying patients of high-risk status. *The Journal of Family Practice* 1991;**33**(5):495–498.

Stehr-Green1993T10 *{published data only}*
Stehr-Green P, Dini E, Lindegren M, Patriarca P. Evaluation of telephoned computer-generated reminders to improve immunization coverage at inner-city clinics. *Public Health Reports* 1993;**108**(4):426–430.

Szilagyi1992T15 *{published data only}*
Szilagyi P, Rodewald L, Savageau J, Yoos L, Doane C. Improving influenza immunization vaccination rates in children with asthma: a test of a computerized reminder system and an analysis of factors predicting vaccination. *Pediatrics* 1992;**90**(6):871–875.

Szilagyi2006T718 *{published data only}*
Szilagyi PG, Schaffer S, Barth R, Shone LP, Humiston SG, Ambrose S, Averhoff F. Effect of telephone reminder/recall on adolescent immunization and preventive vis. *Archives of Pediatric & Adolescent Medicine* 2006;**160**:157–63.

Tollestrup1991T18 *{published data only}*
Tollestrup K, Hubbard B. Evaluation of a follow-up system in a county health department's immunization clinic. *American Journal of Preventive Medicine* 1991;**7**(1):24–28.

Wood1998T105 *{published data only}*
Wood D, Halfon N, Donald-Sherbourne C, Mazel R, Schuster M, Hamlin J, Pereyra M, Camp P, Grabowsky M, Duan N. Increasing immunization rates among inner-city, African American children. A randomized trial of case management. *JAMA* 1998;**279**(1):29–34.

Young1980T63 *{published data only}*
Young S, Halpin T, Johnson D, Irvin J, Marks J. Effectiveness of a mailed reminder on the immunization levels of infants at high risk of failure to complete immunizations. *American Journal of Public Health* 1980;**70**(4):422–424.

References to studies excluded from this review

Abramson1995T66 *{published data only}*
Abramson J, O'Shea M, Ratledge D, Lawless M, Givner L. Development of a vaccine tracking system to improve the rate of age-appropriate primary immunization in children of lower socioeconomic status. *The Journal of Pediatrics* 1995; **126**(4):583–586.

Alemi1996T56 *{published data only}*
Alemi, Alemagno, Goldhagen, Ash, Finkelstein, Lavin, Butts, Ghadiri. Computer reminders imporve on-time immunization rates. *Medical Care* 1996;**34**(10, Supp): OS45–OS51.

Anderson1979T40 *{published data only}*
Anderson C, Martin H. Effectiveness of patient recall system on immunization rates for influenza. *The Journal of Family Practice* 1979;**9**(4):727–730.

Asch-Goodkin2006T703 *{published data only}*
Asch-Goodkin J. Your ever-present practice challenge: keeping the immunization level high. *Contemporary Pediatrics* 2006;**23**(8):72–78.

Barton1990T21 *{published data only}*
Barton, Schoenbaum. Improving influenza vaccination performance in an HMO setting: the use of computer-generated reminders and peer comparison feedback.. *American Journal of Public Health* 1990;**80**(5):534–536.

Bell1993T59 *{published data only}*
Bell J, Whitehead P, Chey T, Smith W, Capon A, Jalaludin B. The epidemiology of incomplete childhood immunization: An analysis of reported immunization status in outer western Sydney. *Journal of Paediatrics and Child Health* 1993;**29**:384–388.

Berg2004T701 *{published data only}*
Berg GD, Thomas E, Silverstein S, Neel CL, Mireles M. Reducing medical service utilization by encouraging vaccines, randomized controlled trial. *American Journal of Preventive Medicine* 2004;**27**(4):284–288.

Berhane1993T13 *{published data only}*
Berhane Y, Pickering J. Are reminder stickers effective in reducing immunization dropout rates in Addis Ababa, Ethiopia?. *The Journal of Tropical Medicine and Hygiene* 1993;**96**(3):139–145.

Britto2006T704 *{published data only}*
Britto MT, Pandzik GM, Meeks CS, Kotagal UR. Combining evidence and diffusion of innovation theory to enhance influenza immunization. *Joint Commission journal on quality and patient safety / Joint Commission Resources* 2006;**32**(8):426–432.

Browngoehl1997T98 *{published data only}*
Browngoehl K, Kennedy K, Krotki K, Mainzer H. Increasing immunization: a Medicaid managed care model. *Pediatrics* 1997;**99**(1):e4.

Bussey1979T64 *{published data only}*
Bussey A, Harris A. Computers and the effectiveness of the measles vaccination campaign in England and Wales. *Community Medicine* 1979;**1**(1):29–35.

Byrne1970T83 *{published data only}*
Byrne EB, Schaffner W, Dini EF, Case GE. Infant immunization surveillance: cost vs. effect. A prospective controlled evaluation of a large-scale program in Rhode Island. *JAMA* 1970;**212**(5):770–773.

Charles1994T100 *{published data only}*
Charles J, Lewis J. Requiring elderly patients to give signed consent for influenza vaccine: does it affect acceptance?. *Canadian Family Physician* 1994;**40**:474–477.

Cleary1995T4 *{published data only}*
Cleary K. Using claims data to measure and improve the MMR immunization rate in an HMO. *Joint Commission Journal on Quality Improvement* 1995;**21**(5):211–217.

Crittenden1994T109 *{published data only}*
Crittenden P, Rao M. The immunisation coordinator: improving uptake of childhood immunisation. *Communicable Disease Report* 1994;**4**(7):R79–R81.

Dini1995T74 *{published data only}*
Dini E, Linkins R, Chaney M. Effectiveness of computer-generated telephone messages in increasing clinic visits. *Archives of pediatrics & adolescent medicine* 1995;**149**: 902–905.

Frank1985T24 *{published data only}*
Frank J, McMurray L, Henderson M. Influenza vaccination in the elderly: 2. The economics of sending reminder letters. *CMAJ* 1985;**132**(5):516–521.

Frank2004T507 *{published data only}*
Frank O, Litt J, Beilby J. Opportunistic electronic reminders. Improving performance of preventive care in general practice. *Australian Family Physician* 2004;**33**(1 - 2):87–90.

Franzini2000T705 *{published data only}*
Franzini L, Rosenthal J, Spears W, Martin HS, Balderas L, Brown M, Milne G, Drutz J, Evans D, Kozinetz C, Oettgen B, Hanson C. Cost-effectiveness of childhood immunization reminder/recall systems in urban private practices. *Pediatrics* 2000;**106**(1):177–183.

Garr1992T62 *{published data only}*
Garr D, Ornstein S, Jenkins R, Zemp L. The effect of routine use of computer-generated preventive reminders in a clinical practice. *American Journal of Preventive Medicine* 1993;**9**(1):55–61.

Gerace1988T91 *{published data only}*
Gerace T, Sangster J. Influenza vaccination: a comparison of two outreach strategies. *Family Medicine* 1988;**20**(1): 43–45.

Grabowski1996T2 *{published data only}*
Grabowsky M, Orenstein W, Marcuse E. The critical role of provide practices in undervaccination. *Pediatrics* 1996;**97** (5):735–737.

Gupta2003T504 *{published data only}*
Gupta S, Roos LL, Walld R, Traverse D, Dahl M. Delivering equitable care: comparing preventive services in Manitoba. *American Journal of Public Health* 2003;**93**(12):2086–2092.

Hak1997T97 *{published data only}*
Hak E, Hermens R, Van Essen G, Kuyvenhoven M, De Melker R. Population-based prevention of influenza in Dutch general practice. *The British Journal of General Practice* 1997;**47**:363–366.

Harper1994T53 *{published data only}*
Harper P, Madlon-Kay D. Adolescent measles vaccination. Response rates to mailings addressed to patients vs parents. *Archives of Family Medicine* 1994;**3**(7):619–622.

Honkanen1997T70 *{published data only}*
Honkanen, Keistinen, Kivela. The impact of vaccination strategy and methods of information on influenza and pneumococcal vaccination coverage in the elderly population. *Vaccine* 1997;**15**(3):317–320.

Hutchinson1995T55 *{published data only}*
Hutchinson H, Norman L. Compliance with influenza immunization: a survey of high-risk patients at a family medicine clinic. *The Journal of the American Board of Family Practice* 1995;**8**(6):448–451.

Hutchison1991T72 *{published data only}*
Hutchison B, Shannon H. Effect of repeated annual reminder letters on influenza immunization among elderly patients. *The Journal of Family Practice* 1991;**33**(2): 187–189.

Johnson2003T509 *{published data only}*
Johnson EA, Harwell TS, Dohahue PM, Weisner M, McInerney MJ, Holzman GS, Helgerson SD. Promoting pneumococcal immunizations among rural Medicare beneficiaries using multiple strategies. *The Journal of Rural Health* 2003;**19**(4):506–510.

Kempe2004T708 *{published data only}*
Kempe A, Beaty BL, Steiner JF, Pearson KA, Lowery E, Daley MF, Crane LA, Berman S. The regional immunization registry as a public health tool for improving clinical practice and guiding immunization delivery policy. *American Journal of Public Health* 2004;**94**(6):967–972.

Kennedy1994T110 *{published data only}*
Kennedy K, Browngoehl K. A "high'tech," "soft-touch" immunization program for members of a Medicaid managed care organization. *HMO Practice* 1994;**8**(3):115–121.

Kljakovic1994T8 *{published data only}*
Kljakovic M. The cost of tracking a cohort of women in a general practice using rubella immune status as an example. *The New Zealand Medical Journal* 1994;**107**(970):6–8.

Kreuter1996T1 *{published data only}*
Kreuter M, Vehige E, McGuire A. Using computer-tailored calendars to promote childhood immunization. *Public Health Reports* 1996;**111**(2):176–178.

Larson1979T41 *{published data only}*
Larson E, Olsen E, Cole W, Shortell S. The relationship of health beliefs and a postcard reminder to influenza vaccination. *The Journal of Family Practice* 1979;**8**(6): 1207–1211.

Leirer1989T73 *{published data only}*
Leirer V, Morrow D, Pariante G, Doksum T. Increasing influenza vaccination adherence through voice mail. *Journal of the American Geriatrics Society* 1989;**37**:1147–1150.

Loeser1983T60 *{published data only}*
Loeser H, Zvagulis I, Hercz L, Pless IB. The organization and evaluation of a computer-assisted, centralized immunization registry. *American Journal of Public Health* 1983;**73**(11):1298–1301.

LudwigBeymer2001T508 *{published data only}*
Ludwig-Beymer P, Hefferan C. Evaluation of baby advocate, a childhood immunization reminder system. *Journal of Nursing Care Quality* 2001;**16**(1):15–23.

MacIntyre2003T510 *{published data only}*
MacIntyre CR, Kainer MA, Brown GV. A randomised, clinical trial comparing the effectiveness of hospital and community-based reminder systems for increasing uptake of influenza and pneumococcal vaccine in hospitalised patients aged 65 years and over. *Gerontology* 2003;**49**:33–40.

Macknin2000T710 *{published data only}*
Macknin J, Marks M, Macknin ML. Effect of telephone follow-up on frequency of health maintenance visits among children attending free immunization clinics: a randomized, controlled trial. *Clinical Pediatrics* 2000;**39**(November): 679–681.

Margolis2004T503 *{published data only}*
Margolis PA, Lannon CM, Stuart JM, Fried BJ, Keyes-Elstein L, Moore DE. Practice based education to improve delivery systems for prevention in primary care: randomized trial. *BMJ* 2004;**328**(7436):388–393.

Marshall1995T43 *{published data only}*
Marshall IB. Screening and vaccination for hepatitis B in Hong Kong University students. *Journal of American College Health* 1995;**44**(2):59–62.

McDowell1990T81 *{published data only}*
McDowell I, Newell C, Rosser W. A follow-up study of patients advised to obtain influenza immunizations. *Family Medicine* 1990;**22**(4):303–306.

Melnikow2000T711 *{published data only}*
Melnikow J, Kohatsu ND, Chan BKS. Put prevention into practice: a controlled evaluation. *American Journal of Public Health* 2000;**90**(10):1622–1625.

Moore1981T108 *{published data only}*
Moore B, Morris D, Burton B, Kilcrease D. Measuring effectiveness of service aides in infant immunization surveillance program in North Central Texas. *American Journal of Public Health* 1981;**71**(6):634–636.

Newman1983T84 *{published data only}*
Newman CPSJ. Immunization in childhood and computer scheme participation. *Public Health* 1983;**97**:208–213.

Nichol1990T20 *{published data only}*
Nichol K, Korn J, Margolis K, Poland G, Petzel R, Lofgren R. Achieving the national health objective for influenza immunization: success of an institution-wide vaccination program. *American Journal of Medicine* 1990;**89**(2): 156–160.

Nichol1992T14 *{published data only}*
Nichol K. Long-term success with the national heatlh objective for influenza vaccination: an institution-wide model. *Journal of General Internal Medicine* 1992;**7**(6): 595–600.

Norman1995T58 *{published data only}*
Norman L, Hardin P, Lester E, Stinton S, Vincent E. Computer-assisted quality improvement in an ambulatory care setting: a follow-up report. *The Joint Commission Journal on Quality Improvement* 1995;**21**(3):116–131.

Ornstein1995T44 *{published data only}*
Ornstein S, Garr D, Jenkins R, Musham C, Hamadeh G, Lancaster C. Implementation and evaluation of a computer-based preventive services system. *Family Medicine* 1995;**27** (4):260–266.

Paunio1991T89 *{published data only}*
Paunio M, Virtanen M, Peltola H, Cantell K, Paunio P, Valle M, Karanko V, Heinonen O. Increase of vaccination coverage by mass media and individual approach: intensified measles, mumps, and rubella prevention program in Finland. *American Journal of Epidemiology* 1991;**133**: 1152–60.

Payne1993T65 *{published data only}*
Payne T, Kanvik S, Seward R, Beeman D, Salazar A, Miller Z, Immanuel V, Thompson R. Development and validation of an immunization tracking system in a large health maintenance organization. *American Journal of Preventive Medicine* 1993;**9**(2):96–100.

Phibbs2006T712 *{published data only}*
Phibbs SL, Hambidge SJ, Steiner JF, Davidson AJ. The impact of inactive infants on clinic-based immunization rates. *Ambulatory Pediatrics* 2006;**6**(3):173–177.

Pierce1996T90 *{published data only}*
Pierce C, Goldstein M, Suozzi K, Gallaher M, Dietz V, Stevenson J. The impact of the standards for pediatric immunization practices on vaccination coverage levels. *JAMA* 1996;**276**(8):626–630.

Quinley2004T501 *{published data only}*
Quinley JC, Shih A. Improving physician coverage of pneumococcal vaccine: a randomized trial of a telephone intervention. *Journal of Community Health* 2004;**29**(2): 103–115.

Reid1984T37 *{published data only}*
Reid J, Graham-Smith H. Childhood immunisations: a recall system is worthwhile. *The New Zealand Medical Journal* 1984;**97**(765):688–689.

Rhew1999T713 *{published data only}*
Rhew DC, Glassman PA, Goetz MB. Improving pneumococcal vaccine rates, nurse protocol versus clinical reminders. *Journal of General Internal Medicine* 1999;**14** (June):351–356.

Rosenberg1995T6 *{published data only}*
Rosenberg Z, Findley S, McPhillips S, Penachio M, Silver P. Community-based strategies for immunizing the "hard-

to-reach" child: the New York State immunization and primary health care initiative. *American Journal of Preventvie Medicine* 1995;**11**(3(Suppl):14–20.

Saunders1970T80 ***{published data only}***
Saunders J. Results and costs of a computer-assisted immunization scheme. *British Journal of Preventive and Social Medicine* 1970;**24**:187–191.

Sellors1997T71 ***{published data only}***
Sellors J, Pickard L, Mahoney J, Jackson K, Nelligan P, Zimic-Vincetic M, Chernesky M. Understanding and enhancing compliance with the second dose of hepatitis B vaccine: a cohort analysis and a randomized controlled trial. *CMAJ* 1997;**157**(2):143–148.

Shefer2006T714 ***{published data only}***
Shefer A, Santoli J, Wortley P, Evans V, Fasano N, Kohrt A, Fontanesi J, Szilagyi P. Status of quality improvement activities to improve immunization practices and delivery: findings from the immunization quality improvement symposium, October 2003. *Journal of Public Health Management and Practice* 2006;**12**(1):77–89.

Stewart1997T102 ***{published data only}***
Stewart P, MacDonald N, Manion I. School-based hepatitis B immunization program: follow-up of non-participants at first school clinic. *Canadian Journal of Public Health* 1997; **88**(3):192–196.

Szilagyi2002T717 ***{published data only}***
Szilagyi PG, Schaffer S, Shone L, Barth R, Humiston SG, Sandler M, Rodewald LE. Reducing geographic, racial, and ethnic disparities in childhood immunization rates by using reminder/recall interventions in urban practices. Pediatrics 2002; Vol. 110, issue 5:e999–e1000.

Thompson1995T94 ***{published data only}***
Thompson R, Taplin S, McAfee T, Mandelson M, Smith A. Primary and secondary prevention services in clinical practice: twenty years' experience in development, implementation, and evaluation. *JAMA* 1995;**273**(14): 1130–1135.

Tucker1987T75 ***{published data only}***
Tucker J, DeSimone J. Patient response to mail cues recommending influenza vaccine. *Family Medicine* 1987; **June/July**:209–212.

Turner1990T22 ***{published data only}***
Turner R, Waivers L, O'Brien K. The effect of patient-carried cards on the performance of health maintenance measures. *Archives of Internal Medicine* 1990;**150**(3): 645–647.

Turner1994T48 ***{published data only}***
Turner R, Peden J, O'Brien K. Patient-carried card prompts vs computer-generated prompts to remind private practice physicians to perform health maintenance measures. *Archives of Internal Medicine* 1994;**154**(17):1957–1960.

VanEssen1997T715 ***{published data only}***
Van Essen GA, Kuyvenhoven MM, De Melker RA. Implementing the Dutch College of General Practitioner's guidelines for influenza vaccination: an intervention study. *British Journal of General Practice* 1997;**47**(414):25–9.

Vernon1976T106 ***{published data only}***
Vernon T, Conner J, Shaw B, Lampe J, Doster M. An evaluation of three techniques for improving immunization levels in elementary schools. *American Journal of Public Health* 1976;**66**:457–460.

Vilella2004T506 ***{published data only}***
Vilella A, Bayas J, Diaz M, Guinovart C, Diez C, Simo D, Munoz A, Cerezo J. The role of mobile phones in improving vaccination rates in travelers. *Preventive Medicine* 2004;**38** (4):503–509.

Vincent1995T3 ***{published data only}***
Vincent E, Hardin P, Norman L, Lester E, Stinton S. The effects of a computer-assisted reminder system on patient compliance with recommended health maintenance procedures. Proceedings--The Annual Symposium on Computer Applications in Medical Care. 1995:656–660.

Waterman1996T103 ***{published data only}***
Waterman S, Hill L, Robyn B, Yeager K, Maes E, Stevenson J, Anderson K. A model immunization demonstration for preschoolers in an inner-city barrio, San Diego, California, 1992-1994. *American Journal of Preventive Medicine* 1996; **12**(Suppl 1):8–13.

Wilcox2001T502 ***{published data only}***
Wilcox SA, Koepke CP, Levenson R, Thalheimer JC. Registry-driven, community-based immunization outreach: a randomized controlled trial. *American Journal of Public Health* 2001;**91**(9):1507–1511.

Wojciechowski1993T88 ***{published data only}***
Wojciechowski B, Darden PM, Ector WL. Effectiveness of postcard prompts for increasing immunizations in children. *AJDC* 1993;**147**:437.

Yokley1984T79 ***{published data only}***
Yokley JM, Glenwick DS. Increasing the immunization of preschool children: an evaluation of applied community interventions. *Journal of Applied Behavior Analysis* 1984;**17** (3):313–325.

Zimmerman2003T505 ***{published data only}***
Zimmerman RK, Nowalk MP, Raymund M, Tabbarah M, Hall DG, Wahrenberger JT, Wilson SA, Ricci EM. Tailedored interventions to increase influenza vaccination in neighborhood health centers serving the disadvantaged. *American Journal of Public Health* 2003;**93**(10):1699–1705.

Additional references

AdHocWorkingGroup
Ad Hoc Working Group for the Development of the Standards for Pediatric Immunization Practices. Standards for pediatric immunization practices. *JAMA* 1993;**269**: 1817–1822.

Arevshatian2007
Arevshatian L, Clements CJ, Misore AO, Ndumbe P, Seward JF, Taylor P. An evaluation of infant immunization in Africa: is a transformation in progress?. *Bulletin of the World Health Organization* 2007;**85**(6):449–457.

Canadian 1998
Canadian Consensus Conference. Canadian Consensus Conference on A National Immunization Records System. http://www.hc-sc.gc.ca/hpb/lcdc/publicat/ccdr/98vol24/dr2417ea.html. 1998.

CDC1997657
Centers for Disease Control and Prevention. Status report on the childhood immunization initiative: national, state, and urban area vaccination coverage levels among children aged 19-35 months-- United States, 1996. *MMWR. Morbidity and Mortality Weekly Report* 1997;**46**:657–664.

CDC1997956
Centers for Disease Control and Prevention. Vaccination coverage by race/ethnicity and poverty level among chilren aged 19-35 months-- United States. MMWR. Morbidity and Mortality Weekly Report 1997:956–9.

CDC19981
Centers for Disease Control and Prevention. Summary of notifiable diseases, United States, 1997. *MMWR. Morbidity and Mortality Weekly Report* 1998;**46**:1–87.

CDC1998547
Centers for Disease Control and Prevention. National, state, and urban area vaccination coverage levels among children aged 19-35 months-- United States, 1997. *MMWR. Morbidity and Mortality Weekly Report* 1998;**47**:547–554.

CDC1998797
Centers for Disease Control and Prevention. Influenza and pneumococcal vaccination levels among adults aged greater than or equal to 65 years-- United States, 1997. *MMWR. Morbidity and Mortality Weekly Report* 1998;**47**:797–802.

CDC199910
Centers for Disease Control and Prevention. Withdrawal of rotavirus vaccine recommendation. *MMWR. Morbidity and Mortality Weekly Report* 1999;**48**:10.

CDC1999243
Centers for Disease Control and Prevention. Achievements in public health, 1900-1999. Impact of vaccines universally recommended for children-- United States, 1990-1998. *MMWR. Morbidity and Mortality Weekly Report* 1999;**48**: 243–248.

CDC1999829
Centers for Disease Control and Prevention. Notice to readers: National vaccination coverage levels among children aged 19-35 months-- United States, 1998. *MMWR. Morbidity and Mortality Weekly Report* 1999;**48**: 829–830.

CDC1999996
Centers for Disease Control and Prevention. Recommendations regarding the use of vaccines that contain thimerosal as a preservative. *MMWR. Morbidity and Mortality Weekly Report* 1999;**48**:996.

CDCP1998
Centers for Disease Control and Prevention. Morbidity and Mortality Report. Initiative on Immunization Registries. http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5017a1.htm.

CDCwebpage
Vaccination coverage levels among children born Febrary 1995- May 1997 --United States, January 1998- December 1998. http://www.cdc.gov/nip/coverage/nis1998_1.htm.

Chalmers 1990
Chalmers TC, Frank Cs, Reitman D. Minimizing the three stages of publication bias. *JAMA* 1990;**263**:1392–5.

Dickerson 1992
Dickerson K, Min YI, Meinert CL. Factors influencing publication of research results. *JAMA* 1992;**267**:374–8.

Easterbrook 1991
Easterbrook PJ, Berlin JA, Gopalon R, et al. Publication bias in clinical research. *Lancet* 1991;**337**:867–872.

Egger 1997
Egger M, Zellweger-Zahner T, Schneider M, Junker C, Lengeler C, Antes G. Language bias in randomized controlled trials published in English and German. *Lancet* 1997;**350**:326–329.

EPOC 2007
Cochrane Effective Practice and Organisation of Care Review Group Data Collection Checklist. http://www.epoc.cochrane.org/Files/Website/Reviewer%20Resources/Data%20Collection%20Checklist%20-%20EPOC%20-%202007-Feb-27.doc. Accessed January 2008.

Excel 2005 [Computer program]
Microsoft Corporation. Microsoft Excel. Microsoft Corporation, 2005.

Fairbrother 1996
Fairbrother G, Friedman S, DuMont KA, Loback KS. Markers for primary care: missed opportunities to immunize and screen for lead and tuberculosis by private physicians serving large numbers of inner-city Medicaid-eligible children. *Pediatrics* 1996;**97**:785–790.

Fedsom 1994
Fedsom DS and the National Vaccine Advisory Committee. Adult immunization: summary of the National Vaccine Advisory Committee Report. *JAMA* 1994;**272**:1133–1137.

Global02
GAVI. Global Alliance for Vaccines and Immunizations (GAVI). http://www.vaccinealliance.org/.

GlobalAlliance 2001
Global Alliance for Vaccines, Immunization. Fact Sheet N169. http://www.who.int/inf-fs/en/fact169.html 2001; Vol. March:1–5.

Gottlieb 1982
Gottlieb MS, Carr JK, Clarkson JR. Drinking water and cancer in Louisiana: a retrospective mortality study. *American Journal of Epidemiology* 1982;**116**:652–667.

Gyorkos 1994
Gyorkos TW, Tannenbaum TN, Abrahamowicz M, Bedard L, Carsley L, Franco ED, Delage G, et al. Evaluation of the effectiveness of immunization delivery methods. *Canadian Journal of Public Health* 1994;**85**(Suppl 1):S14–S30.

Halpern 2000
Halpern R, Boulter P. Population-based health care: definitions and applications. Tufts Managed Care Institute 2000; Vol. November:https://www.thci.org/downloads/topic11_00.PDF.

Heidenreich 1999
Heidenreich PA, McDonald KM, Hastie T, Fadel B, Hagan V, Lee BK, Hlatky MA. Meta-analysis of trials comparing B-blockers, calcium antagonists, and nitrates for stable angina. *JAMA* 1999;**281**:1927–1936.

Higgins 2006
Higgins JPT, Green S, editors. Assessment of study quality. In Cochrane Handbook for Systematic Reviews of Interventions 4.2.6 [updated September 2006]; Section 6. In: The Cochrane Library, Issue 4, 2006. Chichester, UK: John Wiley and Sons, Ltd..

Jacobson Vann 2005
Jacobson Vann JC, Szilagyi P. Patient reminder and patient recall systems for improving immunization rates. *Cochrane Database of Systematic Reviews* 2005, Issue 3. [DOI: 10.1002/14651858.CD003941.pub2

Jadad 1998
Jadad Ar, Cook DJ, Jones A, Klassen TP, Tugwell P, Moher M, Moher D. Methodology and reports of systematic reviews and meta-analyses: a comparison of Cochrane reviews with articles published in paper-based journals. *JAMA* 1998;**280**:278–280.

Linkins 1998
Linkins RW, Feikema SM. Immunization registries: the cornerstone of childhood immunization in the 21st century. *Pediatric Annals* 1998;**27**:349–354.

Massoudi 1999
Massoudi MS, Walsh J, Stokley S, Rosenthal J, Stevenson J, Miljanovic B, Mann J, Dini E. Assessing immunization performance of private practitioners in Maine: impact of the assessment, feedback, incentives, and exchange strategy. *Pediatrics* 1999;**10**:1218–1223.

MMWR 2007
CDC. National, state, and local area vaccination coverage among children aged 19 -- 35 months -- United States, 2006. *MMWR. Morbidity and Mortality Weekly Report* 2007;**56**(34):880–885.

MMWR 2007a
CDC. State-specific influenza vaccination coverage among adults aged >= 18 years -- United States, 2003--04 and 2005 -- 06 influenza seasons. *MMWR. Morbidity and Mortality Weekly Report* 2007;**56**(37):953–959.

NVAC 1991
National Vaccine Advisory Committee. The measles epidemic: the problems, barriers, and recommendations. *JAMA* 1991;**266**:1547–1552.

NVAC 1999
National Vaccine Advisory Committee. Development of community and state-based immunization registries; approved January 12, 1999. Atlanta, GA: US Dept of Health & Human Services, CDC. http://www.cdc.gov/nip/registry/nvac.htm 1999.

OConnor 1998
O'Connor PJ, Pronk NP. Integrating population health concepts, clinical guidelines, and ambulatory medical systems to improve diabetes care. *Journal of Ambulatory Care Management* 1998;**21**(1):67–73.

Rivo1998
Rivo ML. It's time to start practicing population-based health care. *Family Practice Management* 1998;**5**(6):http: www/aafp.org/fpm/980600fm/popbased.html.

Rodewald
Rodewald LE. Personal Communication 2002.

Rodewald 1995
Rodewald LE, Szilagyi PG, Shiuh T, Humiston SG, LeBaron C, Hall CB. Is underimmunization a marker for insufficient utilization of preventive and primary care? . *Archives of Pediatric & Adolescent Medicine* 1995;**149**: 393–397.

Rodewald 1999
Rodewald LE, Szilagyi PG, Humiston SG, Barth R, Kraus R, Raubertas RF, Dietz V. A randomized study of tracking with outreach and provider prompting to improve immunization coverage and primary care. *Pediatrics* 1999; **103**:31–38.

Santoli 1998
Santoli JM, Szilagyi PG, Rodewald LE. Barriers to immunization and missed opportunites. *Pediatric Annals* 1998;**27**:366–374.

Schaffer 1998
Schaffer S, Szilagyi P, Shone L, Humiston S. Adolescent immunization practices: a national survey of U.S. physicians. Plenary presentation at the 1998 APA/SPR/APS National Meeting. New Orleans, LA, May 1998.

Shea 1996
Shea S, DuMouchel W, Bahamonde L. A meta-analysis of 16 randomized controlled trials to evaluate computer-based clinical reminder system for preventive care in the ambulatory setting. *Journal of the American Medical Informatics Association* 1996;**3**:399–409.

Shefer 1999
Shefer AM, Briss PA, Rodewald L, Bernier R, Strikas R, Yusuf H, et al. Improving immunization coverage rates: an evidence-based review of the literature. *Epidemiologic Reviews* 1999;**21**(1):96–142.

Szilagyi 1994
Szilagyi PG, Rodewald LE, Humiston SG, et al. Immumization practices of pediatricians and family physicians in the United States. *Pediatrics* 1994;**94**: 517–523.

Szilagyi 2000
Szilagyi PG, Humiston SG, Shone LP, Kolasa MS, Rodewald LE. Decline in physician-reported referrals to health department clinics for immunizations. The role of

vaccine financing. *American Journal of Preventive Medicine* 2000;**18**(4):318–24.

Task Force 1999
Task Force on Community Preventive Services. Vaccine-preventable diseases: improving vaccination coverage in children, adolescents, and adults. *MMWR. Morbidity and Mortality Weekly Report* 1999;**48**:1–15.

Thompson 1991
Thompson SG, Pocock SJ. Can meta-analyses be trusted?. *Lancet* 1991;**338**:1127–1130.

Udovic 1998
Udovic S, Lieu TA. Evidence on office-based interventions to improve childhood immunization delivery. *Pediatric Annals* 1998;**27**:355–361.

UK 2002
United Kingdom NHS. United Kingdom National Health Service Immunisation site. http://www.immunisation.org.uk/index.html..

UNICEF1996
UNICEF. Sustainability of Achievements: Lessons Learned from Universal Childhood Immunization.. http://www.childrensvaccine.org/files/UNICEF-UCI-Report.PDF 1996.

USDHHS2000
U.S. Dept. of Health & Human Services. Immunizations and infectious diseases: In: Healthy People 2010 (conference ed, vol 1). Washington, DC: US Dept. of Health & Human Services. http://www.health.gov/healthypeople 2000; Vol. 1:41–42.

WHO 2001
WHO. WHO Vaccine Preventable Diseases. 2001 Summary. Monitoring System. http://www.who.int/vaccines-documents/GlobalSummary/Global Summary.pdf. 2001.

WHO 2002
WHO. World Health Organization Vaccines, Immunization, and Biologicals.. http://www.who.int/vaccines/.

WHO 2003
World Health Organization. WHO Polio Eradication.. http://sss.polioeradication.org/..

WHO 2007
World Health Organization. Global Immunization Data. http://www.who.int/immunization/newsroom/Global_imm_data_October2006_revised.pdf, 2006.

References to other published versions of this review

JAMAversion
Peter G. Szilagyi, Clayton Bordley, Julie C. Vann, Ann Chelminski, Ronald M. Kraus, Peter A. Margolis, Lance E. Rodewald. Effect of Patient Reminder/Recall Interventions on Immunization Rates. *JAMA* 2000;**284**(14):1820–1827.

Vann 2005
Jacobson Vann JC, Szilagyi P. Patient reminder and patient recall systems for improving immunization rates. *Cochrane Database of Systematic Reviews* 2005, Issue 3. [DOI: 10.1002/14651858.CD003941.pub2

* *Indicates the major publication for the study*

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Alto1994T54

Methods	Study Design: RCT Study Duration: 6 months (1/1/91-6/30/91) Follow-up: B Outcome Assessment Blinding: B Reliable Outcome Measure: B Contamination: C (patients randomized)
Participants	Inclusion: actively enrolled in practice; not up to date with immunizations Age: 2 months to 7 years Setting: family practice residency clinic (USA) n=464 randomized, 446 analyzed
Interventions	Intervention: Postcard reminder to parent & phone contact 6 weeks after postcard Control: no intervention
Outcomes	#/% of children immunized: 8.8% point increase; #/% children brought up to date: 8.7% point increase
Notes	Did not describe allocation procedure; Abstracted records, but did not report reliability

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Unclear risk	B - Unclear

Baker 1998T96

Methods	Study Design: RCT Study Duration: perhaps 1 flu season Follow-up: B Outcome Assessment Blinding: B Reliable Outcome Measure: A Contamination: C (patients allocated)
Participants	Inclusion: high-risk adult patients aligned with primary care physician Age: adults; mean age=67.2 years Setting: multispecialty group practice, southeastern Michigan (USA) n=24,743 randomized
Interventions	Intervention: (1) generic postcard to patient; (2) personalized postcard from physician; (3) personalized letter from physician, specific to health risk; Control: no reminder, but comprehensive immunization program for all 4 groups

Baker 1998T96 (*Continued*)

Outcomes	#/% receiving influenza vaccination (group 1) 2.9% point increase (group 2) 4.1% point increase (group 3) 4.6% point increase
Notes	Patient reminders were 1 component of a comprehensive influenza immunization program. Used billing data for outcomes. Did not capture vaccinations given at other locations (having free vaccine). possible threshold

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Becker1989T23

Methods	Study Design: RCT Study Duration: 8 months Follow-up: B Outcome Assessment Blinding: A Reliable Outcome Measure: B Contamination: C (patients allocated)
Participants	Inclusion: has recorded phone #, at least 1 clinic visit within 18 months, residence outside Long Term Care facility (nursing home or psychiatric) Age: 40-60 years; Setting: U of Virginia internal medicine clinic (USA) n= 360 patients (immunization study arms)
Interventions	Intervention (1) mailed memo to patient & physician reminder clipped to chart; (2) physician reminder clipped to chart; Control: no reminder; no intervention
Outcomes	Immunization rates: pneumococcal (0.8% point increase), tetanus (8.2% point increase), influenza (16% point increase)
Notes	Multiple interventions (patient & provider reminders). Variable follow-up for each outcome measure

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Brimberry1988T33

Methods	Study Design: RCT Study Duration: 3 months Follow-up: A Outcome Assessment Blinding: A Reliable Outcome Measure: B Contamination: C (patients randomized)
Participants	Inclusion: in active patient computer files; high risk for influenza & complications Age: not clear Setting: Family Medical Center, University of Arkansas (USA) n=787 patients
Interventions	Intervention: (1) mailed form letter; (2) telephone reminder ; Control: No intervention
Outcomes	#/% receiving influenza vaccination (1) 5.9% point increase (2) 5.5% point increase
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Buchner1987T34

Methods	Study Design: RCT Study Duration: possibly 1 influenza season (1984) Follow-up: C Outcome Assessment Blinding: A Reliable Outcome Measure: B Contamination: C (patients randomized)
Participants	Inclusion: active patients, not nursing home resident, no flu shot or egg allergy Age: >=65 years Setting: private practices of 3 internists near Seattle, Washington (USA) n=655 patients randomized; 540 analyzed
Interventions	Intervention: Postcard reminder in business envelope Control: no intervention
Outcomes	% receiving influenza vaccination; 1.0 percentage point increase
Notes	

Buchner1987T34 (*Continued*)

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Unclear risk	B - Unclear

Buffington1991T29

Methods	Study Design: RCT Study Duration: 3 months Follow-up: B Outcome Assessment Blinding: C Reliable Outcome Measure: B Contamination: A
Participants	Inclusion: active patients Age: >= 65 years Setting: private physicians office setting, Rochester, New York (USA) n=45 physicians; 8,376 patients
Interventions	Intervention: Postcard reminder & provider poster/chart Control: no intervention
Outcomes	% of patients receiving influenza vaccination; 17% point increase
Notes	Randomized at practice/provider level, analyzed at patient level; data not entered in RevMan; Odds Ratio=2.0; CI (adjusted for intrapractice variation) = 0.67, 5.93

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Unclear risk	B - Unclear

Campbell1994T87

Methods	Study Design: RCT Study Duration: 7-13 months Follow-up: A Outcome Assessment Blinding: B Reliable Outcome Measure: B Contamination: B
Participants	Inclusion: infants enrolled at clinic, but not those receiving well care from first author Age: infants birth - 7 months Setting: pediatric continuity clinic in teaching hospital, Rochester, New York (USA)

Campbell1994T87 (*Continued*)

	n=288 patients enrolled & analyzed
Interventions	Intervention: (1) letter one week before appointment; (2) postcard reminder one week before appointment Control: no reminder letter or postcard
Outcomes	#/% receiving 3 DTP by 7 months of age (group 1) 5.9% point increase (group 2) 2.5% point increase
Notes	Chart audits performed to determine date DTP received; Letters reminded patients of appointments & discussed several topics; postcards reminded patients of appointments only

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Unclear risk	B - Unclear

Carter1986T104

Methods	Study Design: RCT, stratified by age & diagnosis Study Duration: 2 week flu shot clinic in October Follow-up: A Outcome Assessment Blinding: A (done for survey) Reliable Outcome Measure: A Contamination: C (patients allocated)
Participants	Inclusion: patients at high risk for influenza complications who had not received flu shot in previous year Age: adults Setting: Veterans Administration Medical Center, general medical clinic, Seattle, Washington (USA) n=284 patients
Interventions	Intervention: (1) standard letter & informational brochure; (2) augmented letter; (3) augmented letter & informational brochure; Control: standard letter used as comparison
Outcomes	#/% receiving influenza immunization; (group 1) 13% point increase (group 2) 7% point increase (group 3) 23% point increase
Notes	Control group includes a patient reminder (standard letter), so no true control group

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**

Carter1986T104 (*Continued*)

Allocation concealment?	Unclear risk	B - Unclear

Daley2004T513

Methods	Study Design: RCT Study Duration: 7/2002 through 5/2003 (11 months) Follow-up: B Outcome Assessment Blinding: B Reliable Outcome Measure: C Contamination: C (patients allocated)
Participants	Inclusion: pediatric patients with high-risk conditions, record in registry & billing database, & clinic visit within 18 months Providers: pediatricians & mid-level provders Age: 6 to 72 months Setting: 4 private pediatric practices, Denver, Colorado (USA) n = 1851
Interventions	Intervention: staged reminder letter & postcard recall Control: standard practice (may have included some personal reminders)
Outcomes	#/% receiving influenza vaccination; 17 percentage point increase
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Low risk	A - Adequate

Daley2004T515

Methods	Study Design: RCT Study Duration: 2 months (June - July 2000) Follow-up: B Outcome Assessment Blinding: B Reliable Outcome Measure: B Contamination: C (patients allocated)
Participants	Inclusion: children not up to date with immunizations Age: 5 to 17 months Setting: pediatric primary care clinic of an inner-city teaching hospital, Denver, Colorado (USA) n = 420

Daley2004T515 (*Continued*)

Interventions	Intervention: postcard reminder to parents; phone recall if not seen or scheduled Control: standard practice (includes quality improvement initiative, chart prompts, provider reminders)
Outcomes	#/% up to date with immunizations (point estimates); 1 percentage point increase
Notes	Very brief study period (2 months) to get children up-to-date (may not be sufficient); QI did not improve accuracy of parent contact information; other SES barriers may have contributed to results

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Ferson1995T57

Methods	Study Design: RCT Study Duration: approximately 3-5 months Follow-up: C Outcome Assessment Blinding: B Reliable Outcome Measure: C Contamination: C (patients randomized)
Participants	Inclusion: school children located where child health screening occurred in 1991 Age: 5-6 years, in kindergarten Setting: 28 primary schools in Eastern Sydney (Australia) n=239 children
Interventions	Intervention: Telephone call, letter & brochure to parents Control: letter & brochure to parents
Outcomes	#/% immunized for measles, mumps & DTP; 34% point increase
Notes	25.8% of intervention & 34.4% of control subjects lost to follow-up. Control group also included patient reminder; Outcomes obtained verbally from parents

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Frame1994T52

Methods	Study Design: RCT (stratified using 4 criteria) Study Duration: 2 year study; 1 year followup per intervention Follow-up: B Outcome Assessment Blinding: B Reliable Outcome Measure: B Contamination: C (randomized families)
Participants	Inclusion: families active in the practice Age: 21 years of age or older Setting: rural, multiple office, nonprofit, fee-for-service, family practice; Dansville, New York (USA) n=1008 families; 1665 adult family members
Interventions	Intervention: telephone reminders to patients, computer-generated health maintenance status report on chart & 2 hour provider instruction session; Control: Manual flowchart based health maintenance tracking system
Outcomes	Provider compliance with health maintenance protocol (% immunized for Tetanus-Diphtheria); 20% point increase
Notes	Randomized families; data not entered in RevMan

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Unclear risk	B - Unclear

Hogg1998T101

Methods	Study Design: RCT Study Duration: 1990-91 (1 year) Follow-up: A Outcome Assessment Blinding: A Reliable Outcome Measure: A Contamination: C (patients allocated)
Participants	Inclusion: registered patients who made >= 1 visit in previous 2 years Age: mean = 37.1-41.6 years Setting: community-based care; rural family medicine center (Canada) n=1998 patients; 719 families
Interventions	Intervention: (1) computer-generated customized letters; (2) form letter to patients; Control: no letters, but physician reminder system existed for all patients
Outcomes	#/% overdue who received adult tetanus, flu > 65 years, flu (chronic disease), MMR, HIB, DPT, & TOPV immunizations; Outcome range: 5.9% point decrease to 2.6% point increase

Hogg1998T101 (*Continued*)

Notes	Computerized allocation of families; Baselines differed significantly

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Hull2002T511

Methods	Study Design: RCT Study Duration: 9/00 - 10/00 (2 months) Follow-up: A Outcome Assessment Blinding: A Reliable Outcome Measure: B Contamination: C (patients allocated)
Participants	Inclusion: registered patients w/o chronic disease; Age: 65 - 74 years Setting: 3 general practices (UK) n = 1261 patients
Interventions	Intervention: phone call to patient Control: untargeted activity (city sent letter & brochure)
Outcomes	Influenza immunization rates; 5.9 percentage point increase
Notes	Reported differences as percent rather than percentage point changes (probable error). allocated households resulting in unit of analysis error; adjusted OR in paper (minimal effect). Included data

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Irigoyen2006T702

Methods	Study Design: RCT Study Duration: 9/11/01 - 3/31/02 (6.5 months) Follow-up: A Blinding: B Reliable Outcome Measure: C Contamination: C (patients allocated)
Participants	Inclusion: visit to network & due for DTaP Age: 6 weeks to 15 months Setting: 5 community- based peds practice, New York city (USA) n = 1662
Interventions	Intervention: (1) continuous reminders (weekly postcards) (2) limited reminders (up to 3 postcards) Control: no intervention
Outcomes	Up to date with DTaP; 4.3 percentage point increase
Notes	25.6% misclassification of DTaP; postcards returned for 13.6% children; vaccine shortage

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Low risk	A - Adequate

Kempe2001T706

Methods	Study Design: RCT Study Duration: 9/1/03 - 2/29/04 Follow-up:B Blinding: B Reliable Outcome Measure: A Contamination: C (patients randomized)
Participants	Inclusion: children visiting practices in previous 18 months & in immunization registry Age: 6 to 21 months Setting: 5 peds practices in metropolitan Denver, Colorado (USA) n = 5193
Interventions	Intervention: up to 3 reminder/recall letters generated by registry Control: standard practice
Outcomes	Receipt of 1 or more influenza immunizations 2003 - 2004 season; 4.4 percentage point increase

Kempe2001T706 (*Continued*)

Notes	Possible contamination of both groups may have attenuated the observed effect: telephone survey before intervention & pandemic w extensive media coverage

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Kempe2005T707

Methods	Study Design: RCT Study Duration: January - July 1999 (6-7 months) Follow-up: B Blinding: A Reliable Outcome Measure: B Contamination: C (patients randomized)
Participants	Inclusion: seen for well-child care or acute illness in clinic Age: 5 to 17 months Setting: inner-city hospital-based teaching clinic, Denver, Colorado (USA) n = 603
Interventions	Intervention: Postcard & attempts to call; provider prompts; Control: provider prompts
Outcomes	Up to date with immunizations; 4 percentage point decrease to 12 percentage points increase
Notes	Provider prompts for both groups may have influenced results; data somewhat unclear; inadequate immunization records for ~ 18%; unable to contact 28.1%

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Kemper1993T11

Methods	Study Design: RCT Study Duration: 1 flu season (fall 1991) Follow-up: A Outcome Assessment Blinding: A Reliable Outcome Measure: B Contamination: C (patients randomized)
Participants	Inclusion: received primary care at 1 children's clinic; 2 or more emergency/clinic visits in past year for asthma Age: children at least 6 months old Setting: primary clinic serving poor, urban children in Seattle, Washington (USA) n=96 randomized
Interventions	Intervention: one computer-generated letter to parent & standing order; Control: standard practice (memo to providers on recommendations)
Outcomes	#/% children immunized with influenza vaccine; 26 percentage point increase
Notes	

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Low risk	A - Adequate

Larson1982T39

Methods	Study Design: RCT Study Duration: possibly 1 influenza season Follow-up: C Outcome Assessment Blinding: B Reliable Outcome Measure: B Contamination: C (patients randomized)
Participants	Inclusion: high risk patients (for serious complications from influenza vaccination) Age: mean = 66.7 years Setting: U of Washington Family Medical Center (USA) n=395 randomized; data collection on 283
Interventions	Intervention: (1) neutral postcard; (2) health belief model postcard; (3) personal postcard; Control: no intervention
Outcomes	% vaccinated for influenza; (group 1) 4.8% point increase (group 2) 31.2% point increase (group 3) 20.8% point increase

Larson1982T39 (*Continued*)

Notes	follow-up on 71.6% of persons initially selected & randomized & on 92% of persons remaining; vaccination status obtained by patient self report if patient did not come to clinic for vaccination

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

LeBaron1998T78

Methods	Study Design: CBA Study Duration: 1 year; 9/1/92 - 8/31/93 Follow-up: B Outcome Assessment Blinding: A Reliable Outcome Measure: B Contamination: A
Participants	Inclusion: patients of 4 clinics or residents of 9 communities Age: 3 to 59 months Setting: community based organization; Fulton County, Georgia (USA) n= 4 public clinics; 9 inner city communities
Interventions	Intervention: (1) "clinic": phone, mail or home visit with family; (2) "community": door-to-door campaign; Control: no intervention
Outcomes	Age-appropriate vaccination rates; series completion rates; Immunizations increased by 15 % points in intervention groups; no change in controls
Notes	Data not entered in RevMan; CBA, allocation by practice

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	D - Not used

LeBaron2004T512

Methods	Study Design: RCT Study Duration: 9/1996 - 8/1998 (2 years) Follow-up: B Outcome Assessment Blinding: C Reliable Outcome Measure: B Contamination: C (patients allocated)
Participants	Inclusion: inner city birth cohort, patients of public facilities Providers: city-wide hospital, clinic, health dept. Age: 1 to 14 months Setting: Atlanta, Georgia (USA) n = 3050
Interventions	Intervention: (1) autodialer; (2) outreach; (3) autodialer & outreach Control: standard practice (may include postcard reminders)
Outcomes	Age-appropriate vaccination rates' (group 1) 6% point increase (group 2) 3% point increase (group 3) 4% point increase
Notes	Limitation: postcard recall systems in control group may have attenuated the results; lacked vaccination records from providers not in registry

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Lieu1997T69

Methods	Study Design: RCT Study Duration: 4 months per subject Follow-up: A Outcome Assessment Blinding: A Reliable Outcome Measure: A Contamination: C (patients allocated)
Participants	Inclusion: enrolled children at 2 medical centers Age: 20 months between 1/94 & 11/94 Setting: Kaiser Permanente (group model Health Maintenance Organization), northern California (USA) n=321 patients randomized
Interventions	Intervention: personalized letter & brochure; Control: no letter

Lieu1997T69 (*Continued*)

Outcomes	#/% MMR recorded on Kaiser immunization tracking system or parental report of MMR received outside the system (by 24 months): 19% point increase
Notes	Randomized patients using random number generator

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Lieu1998T82

Methods	Study Design: RCT with nonrandomized controls Study Duration: 9/96 - 1/97 Follow-up: A Outcome Assessment Blinding: A Reliable Outcome Measure: A Contamination: C (patients randomized)
Participants	Inclusion & Age: underimmunized 20 month olds identified by HMO (Health maintenance organization) Setting: HMO, Northern California (USA) n: 752 randomized, 648 analyzed
Interventions	Intervention: (1) automated phone message followed by letter; (2) automated phone message; (3) letter; (4) letter followed by automated phone message Control: no systematic intervention
Outcomes	#/% needed immunizations received by 24 months; Odds Ratios for combined interventions = 2.1 & 2.5; (group 1) 17.7% point increase (group 2) 8.2% point increase (group 3) 8.6% point increase (group 4) 22.2% point increase
Notes	Computerized immunization tracking system may not have complete vaccine information for children enrolled after 42 days of age; randomized to 4 intervention groups; control groups were nonrandomized

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Linkins1994T49

Methods	Study Design: RCT Study Duration: 1 month Follow-up: A Outcome Assessment Blinding: A Reliable Outcome Measure: A Contamination: A
Participants	Inclusion: if computerized immunization record had phone # Age: < 2 years Setting: 14 counties in urban & rural Georgia (USA) n=8,002 patients
Interventions	Intervention: computer-generated phone reminders (general vs. specific reminders) Control: no intervention
Outcomes	rates of immunization visits (childhood vaccines); 7.9% point increase
Notes	contacted 70.3% of households; allocated after determined immunization status; randomized patients in 14 counties

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Low risk	A - Adequate

Lukasik1987T85

Methods	Study Design: RCT (alternate assignment) Study Duration: 9/85 - 12/95 (3 months) Follow-up: A Outcome Assessment Blinding: B Reliable Outcome Measure: B Contamination: C (patients allocated)
Participants	Inclusion & Age : all active registered patients in the practice 65+ years Setting: single family practice center (teaching), London, Ontario (Canada) n=243
Interventions	Intervention: phone call to patient & reminder sticker on clinic chart; Control: notification at clinic visit & reminder sticker on clinic chart
Outcomes	#/% receiving influenza vaccine: 24% point increase
Notes	Patients allocated within one practice; allocated households, data not entered in RevMan

Risk of bias

Lukasik1987T85 (*Continued*)

Bias	Authors' judgement	Support for judgement
Allocation concealment?	High risk	C - Inadequate

Margolis1992T17

Methods	Study Design: CBA Study Duration: approximately 7 months; 8/89-3/90 Follow-up: Outcome Assessment Blinding: C Reliable Outcome Measure: Contamination:
Participants	Age: 65 and older Setting: 4 clinics in staff model Health Maintenance Organization (HMO), Minneapolis, Minnesota (USA) n=600
Interventions	Intervention: letter to patients, standing order & reminder sticker on appointment roster; Control: no intervention
Outcomes	#/% patients receiving influenza vaccination; Percentage point changes: in 2 intervention clinics: -5 to +16; control: +3 to -4
Notes	Results not in RevMan data tables. After the intervention: Clinic 1 showed no significant change, Clinic 2 had a significant increase, Control clinics remained relatively stable; Pre-intervention OR/Post-Intervention Odds Ratio = 1.32

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	D - Not used

McDowell1986T46

Methods	Study Design: RCT Study Duration: 2 months (10/84-12/84) Follow-up: A Outcome Assessment Blinding: A Reliable Outcome Measure: A Contamination: B
Participants	Inclusion: patients registered in 4 practices Age: >=65 years Setting: U. of Ottawa Family Medicine Center, Civic Hospital (Canada) n=1420 total patients; 939 patients included in trial

McDowell1986T46 (*Continued*)

Interventions	Interventions: (1) patient reminder in person by physician; (2) patient reminder by telephone; (3) patient reminder letter; Control: (1) no intervention control group; (2) non participating controls
Outcomes	#/% receiving influenza vaccination; (group 1) 13.1% point increase (group 2) 27.2% point increase (group 3) 25.3% point increase
Notes	3 distinct patient reminders were studied; patients in 2 non-participating practices had lowest vaccination %; allocated families; allocated families; data not included in RevMan

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Low risk	A - Adequate

Moran1992T16

Methods	Study Design: RCT Study Duration: possibly 1 flu season Follow-up: A Outcome Assessment Blinding: B Reliable Outcome Measure: A Contamination: C (randomized patients)
Participants	Inclusion: high risk patients seen between 2/90 & 9/90 Age: half < 65 years, half >= 65 years Setting: urban community health center, (USA) n=409
Interventions	Intervention: 1 or 2 reminder letter(s) to patients; Control: no intervention
Outcomes	#/% immunized with influenza vaccination One letter: 1.8 percentage point increase; two letters: 8.5 percentage point decrease
Notes	Could not assess immunizations received at another site

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Unclear risk	B - Unclear

Mullooly1987T67

Methods	Study Design: RCT Study Duration: 8 months Follow-up: B Outcome Assessment Blinding: B Reliable Outcome Measure: B Contamination: C (patients randomized)
Participants	Inclusion: high risk elderly HMO members; discharged alive from hospital; 10/83-9/84 Age: 65+ years Setting: Kaiser Permanente HMO, Portland, Oregon & Vancouver, Washinton metropolitan area (USA) n=2217 (1105 intervention, 1112 controls)
Interventions	Intervention: personalized persuasive letter sent to patients; Control: standard practice (members notified by newsletter about how to obtain a vaccination)
Outcomes	% of eligible persons receiving influenza vaccination: 8.8% point increase; pneumococcal vaccinations also noted
Notes	Randomized patients using "pseudo-random digit" of individual membership ID#;

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Unclear risk	B - Unclear

Nexoe1997T92

Methods	Study Design: RCT Study Duration: 9/95 - 12/95 (3 months) Follow-up: A Outcome Assessment Blinding: B Reliable Outcome Measure: B Contamination: C (patients allocated)
Participants	Inclusion: 45 patients selected consecutively per practice Age: 65+ years Setting: 13 general practices (Denmark) n=585
Interventions	Intervention: (1) postal invitation & free vaccine; (2) postal invitation & usual charge; Control: no intervention
Outcomes	#/% receiving influenza vaccine; Combined intervention more effective; (group 1) 47% point increase (group 2) 24% point increase

Nexoe1997T92 (*Continued*)

Notes	Patients randomized to 3 groups within each practice

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	High risk	C - Inadequate

Oeffinger1992T27

Methods	Study Design: RCT Study Duration: 1 year Follow-up: B Outcome Assessment Blinding: B Reliable Outcome Measure: B Contamination: C (randomized patients)
Participants	Inclusion: mothers & newborns delivered by Family Practice residents Age: enrolled as infants Setting: McLennan County Family Practice residency (USA) n=238 infants
Interventions	Intervention: reminder letter to parents, 10-15 minute patient education session, & 1 page handout; Control: no intervention
Outcomes	% immunized for DTP/OPV (Oral Polio) (first, second, & third doses); 3 months: 2% point decrease 5 months: 7% point increase 12 months: 4% point increase
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	High risk	C - Inadequate

Ornstein1991T30

Methods	Study Design: RCT Study Duration: 1 year Follow-up: A Outcome Assessment Blinding: A Reliable Outcome Measure: C Contamination: B
Participants	Inclusion: Active patients Age: >=18 years Setting: Family Medicine Center, Medical University of South Carolina (USA) n=7,397 patients
Interventions	Intervention: (group 1) 2 reminder letters to patients; (group 2) reminder letters & physician computerized reminders; Control: educational sessions for residents, quarterly audits & flow sheet on chart
Outcomes	% persons receiving tetanus vaccine; (group 1) 3.6% point increase (group 2) 13.4% point increase
Notes	Intervention group also included "control" activities. Study also examined combination of provider and patient reminders. Providers allocated; data not included in RevMan

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Unclear risk	B - Unclear

Puech1998T99

Methods	Study Design: RCT; Study Duration: 4/1/96 - 7/31/96 (4 months) Follow-up: A Outcome Assessment Blinding: A Reliable Outcome Measure: A Contamination: C (allocated patients)
Participants	Inclusion & Age: all nonresidential patients of the practice 65+ years of age Setting: 3 partner urban general practice (Australia) n=325 patients (stratified by gender)
Interventions	Intervention: single postcard reminder in April; Control: standard care
Outcomes	#/% receiving influenza vaccination: 9.5% point increase

Puech1998T99 (*Continued*)

Notes	Intervention more effective for men; Computer-generated random numbers used to allocate patients; Blinded record audit in July; Controls may have been exposed to mass media campaign; allocated patients (married couples grouped); data not entered in RevMan

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Rodewald1999T95

Methods	Study Design: RCT (2 by 2 factorial design) Study Duration: 3/94-8/95 (18 months) Follow-up: A Outcome Assessment Blinding: A Reliable Outcome Measure: B Contamination: C (patients randomized)
Participants	Inclusion: all children in 9 practices born between 3/1/93 & 2/28/94 Age: 0-12 months Setting: 9 primary care sites serving impoverished & middle class children, Rochester, New York (USA) n=3,015 patients randomized
Interventions	Intervention: (1) tracking with outreach; (2) provider prompts; (3) tracking, outreach & provider prompts; Control: no intervention
Outcomes	#/% "up-to-date" for age- appropriate series completion; DTP, OPV, MMR, Hib; (group 1) 21% point increase (group 3) 21% point increase
Notes	1 month grace period on series completion; follow-up on 90-94% of patients; performed dual review of 10% of charts (unknown results); allocated patients (siblings not split), data not entered in RevMan

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Rosser1991T61

Methods	Study Design: RCT Study Duration: 4 months (influenza); 1 year (tetanus) Follow-up: C Outcome Assessment Blinding: A Reliable Outcome Measure: A Contamination: C (patients randomized)
Participants	Inclusion: patients active in practice; not in hospital or institution Age: >=15 years Setting: Ottawa Civic Hospital Family Medicine Centre (Canada) n=5,883 patients randomized
Interventions	Intervention: (1) telephone reminder to patient; (2) reminder letter to patient; Control: no intervention
Outcomes	% procedures performed: tetanus vaccine: (group 1) 20.8% point increase; (group 2) 27.4% point increase; flu vaccines: (group 1) 27.2% point increase (group 2) 25.4% point increase
Notes	62% of phone reminder people were contacted; families allocated; data not entered in RevMan

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Low risk	A - Adequate

Rosser1992T47

Methods	Study Design: RCT Study Duration: 1-2 years Follow-up: A Outcome Assessment Blinding: A Reliable Outcome Measure: B Contamination: A
Participants	Inclusion: patients not in hospital or institution Age: 20+ years Setting: Ottawa Civic Hospital Family Medicine Centre, 4 practices (Canada) n=5,589; 3 distinct interventions

Rosser1992T47 (*Continued*)

Interventions	Interventions: (1) in person patient reminder by physician; (2) telephone patient reminder; (3) patient reminder letter; Control: (1) no reminder; (2) two nonparticipating practices
Outcomes	% patients vaccinated during study period with tetanus booster or clear statement of receipt in past 10 years; (group 1) 19.6% point increase (group 2) 20.8% point increase (group 3) 27.4% point increase
Notes	2 non- participating practices were compared to check for contamination of controls; allocated families; data not entered in RevMan

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Low risk	A - Adequate

Sansom2003T514

Methods	Study Design: RCT (allocated by week) Study Duration: 1/1999 through 11/1999 (11 months) Follow-up: A Outcome Assessment Blinding: B Reliable Outcome Measure: B Contamination: C (patients allocated)
Participants	Inclusion: male patients who reported susceptibility to Hepatitis A or B Age: 18 years & older Setting: Los Angeles Gay & Lesbian Center's Sexual Health Program, California (USA) n = 524
Interventions	Interventions: telephone reminders Control: no intervention (appointment card only for next vaccine)
Outcomes	#/% receiving 2nd dose Hepatitis B; 6.3 percentage point increase
Notes	Allocated subjects by week enrolled; 16.1% intervention patients did not receive full intervention for 2nd Hep B dose

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	High risk	C - Inadequate

Satterthwaite1997T93

Methods	Study Design: RCT Study Duration: not clear Follow-up: B Outcome Assessment Blinding: B Reliable Outcome Measure: B Contamination: C (patients randomized)
Participants	Inclusion: patients of 16 General Practitioners Age: 65+ years Setting: 16 general practitioners in Auckland region (New Zealand) n=2791
Interventions	Intervention: (1) letter to patients; (2) letter to patients announcing free vaccine; Control: no intervention
Outcomes	#/% receiving influenza vaccination; (group 1) 10% point increase (group 2) 28% point increase
Notes	Authors note: there may have been more rigorous recording (vaccine) procedures for "free vaccine" group

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Unclear risk	B - Unclear

Siebers1985T36

Methods	Study Design: RCT Study Duration: 1 year Follow-up: A Outcome Blinding Assessment: A Reliable Outcome Measure: B Contamination: C (patients randomized)
Participants	Inclusion: continuing care patients in computer file Age: >=65 years Setting: General Internal Medicine Clinic, U of Wisconsin, Madison (USA) n=243 patients
Interventions	Intervention: patient reminder letter & seminar on pneumovax to clinic staff; Control: seminar to staff (as in Intervention grp)
Outcomes	% receiving pneumococcal vaccine (20% point increase); % receiving influenza vaccine (22% point increase)
Notes	

Siebers1985T36 (*Continued*)

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Unclear risk	B - Unclear

Soljak1987T35

Methods	Study Design: RCT nested within larger study Study Duration: 5 months Follow-up: A Outcome Assessment Blinding: A Reliable Outcome Measure: A Contamination: C (patients allocated)
Participants	Inclusion: Test group=all infants born between 4/20/85 & 12/31/85; Controls=all infants born between 1/1/85 & 4/20/85 Age: infants Setting: Northland area (New Zealand) n=2088 patients
Interventions	Intervention: reminder card sent to patient & monthly printout sent to GP with names of children due for immunizations; Control: standard practice
Outcomes	Receipt of childhood immunizations: % immunized at 6 weeks: 18.2% point increase & at 3 and 5 months
Notes	Patients allocated first by date of birth, then further allocated by even & odd dates of birth

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	High risk	C - Inadequate

Spaulding1991T28

Methods	Study Design: RCT Study Duration: 6 months Follow-up: A Outcome Assessment Blinding: B Reliable Outcome Measure: A Contamination: C (allocated patients)

Spaulding1991T28 (*Continued*)

Participants	Inclusion: high risk patients Age: all ages (not clear) Setting: Dept. of Family Practice, Madigan Army Medical Center, Fort Lewis, Washington (USA) n=1068 patients
Interventions	Intervention: reminder postcard; Control: no intervention
Outcomes	% of persons receiving influenza vaccine; 16.1% point increase
Notes	families allocated, patients analyzed; data not entered in RevMan

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Unclear risk	B - Unclear

Stehr-Green1993T10

Methods	Study Design: RCT Study Duration: 1month Follow-up: C Outcome Assessment Blinding: B Reliable Outcome Measure: B Contamination: C (patients randomized)
Participants	Inclusion: previously vaccinated at 2 public health clinics; due to receive DTP, OPV or MMR; Atlanta, Georgia (USA) Age: younger than 2 years n=222 randomized
Interventions	Intervention: autodialer (1 per patient); Control: no intervention
Outcomes	#/% children vaccinated on time (childhood vaccines); 2.8 percentage point increase
Notes	67.3% follow-up in intervention group; estimated intervention costs only

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Unclear risk	B - Unclear

Szilagyi1992T15

Methods	Study Design: RCT Study Duration: 4 months Follow-up: B Outcome Assessment Blinding: A Reliable Outcome Measure: B Contamination: C (patients randomized)
Participants	Inclusion: moderate to severe asthma Age: 1 to 18 years Setting: Pediatric clinic serving impoverished urban children, Rochester, New York (USA) n=124
Interventions	Intervention: one computer-generated letter to parents; Control: standard practice (provider education & computerized checklist on medical record)
Outcomes	#/% of patients receiving influenza vaccination; 23 percentage point increase
Notes	No cost data

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment?	Unclear risk	B - Unclear

Szilagyi2006T718

Methods	Study Design: RCT Study duration: 18 months 8/8/1998 to 2/29/2000 Follow-up: A Outcome Assessment Blinding: A Reliable Outcome Measure: A Contamination: C (patients allocated)
Participants	Inclusion: 1 or more visits at clinic sites. Age: 11 - 14 years Setting: 4 urban clinics (1 outpatient; 2 pediatric group practices; 1 family medicine neighborhood) N = 3006 randomized and analyzed
Interventions	Intervention: automated telephone message reminder system (autodialer); # varied per participant; Control: not clear
Outcomes	Up-to-date for Hepatitis B vaccine; Up to date for Td; used average values
Notes	62.8% did not respond to reminders; 3.4% no longer patients of the clinics; 9.8% wanted calls discontinued

Szilagyi2006T718 (*Continued*)

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Low risk	A - Adequate

Tollestrup1991T18

Methods	Study Design: CBA with equivalent baselines Study Duration: 2 months Follow-up: A Outcome Assessment Blinding: B Reliable Outcome Measure: B Contamination: A
Participants	Inclusion: received first or second DTP from main health department. clinic Age: children < 5 years Setting: county health dept, urban area; Everett, Washington (USA) n=425 enrolled; 393 followed
Interventions	Intervention: 1-2 postcard reminders; Control: no intervention
Outcomes	#/% immunized for DTP; 33.9 percentage point increase
Notes	Analyzed "overdue" children (n=173); included in pooled results

Risk of bias		
Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Unclear risk	D - Not used

Wood1998T105

Methods	Study Design: RCT; Study Duration: not clear, 15 months follow-up Follow-up: A Outcome Assessment Blinding: B Reliable Outcome Measure: B Contamination: C (patients allocated)
Participants	Inclusion: inner-city African American children of 10 zip code areas Age: infants; mean of 17.8 days (at enrollment) Setting: low-income area of Los Angeles, California (USA) n=419 infants

Wood1998T105 (*Continued*)

Interventions	Intervention: case management with phone calls & Health passport; Control: Health passport (schedule of recommended well child visits & immunizations)
Outcomes	#/% up-to-date with childhood immunizations at 1 year of age: 13.2% point increase
Notes	Randomized mother-infant pairs; 87% follow-up

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Unclear risk	B - Unclear

Young1980T63

Methods	Study Design: RCT Study Duration: 1 month Follow-up: C Outcome Assessment Blinding: B Reliable Outcome Measure: B Contamination: C (patients randomized)
Participants	Inclusion: 25% of Ohio's live, legitimate resident births classified as "high risk"; Age: 6 months Setting: Ohio (USA) n=507 patients randomized; 355 respondents
Interventions	Intervention: reminder letter to parents; Control: no reminder letter
Outcomes	#/% children receiving childhood vaccines: 16% point increase; #/% children brought up to date with vaccinations: 12% point increase
Notes	70.5% response to questionnaire to obtain outcomes; randomization procedures not explicit

Risk of bias

Bias	**Authors' judgement**	**Support for judgement**
Allocation concealment?	Unclear risk	B - Unclear

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Abramson1995T66	Article was retracted. Study location: North Carolina (USA).
Alemi1996T56	Study design: not RCT, CBA or ITS. Study location: Cleveland, Ohio (USA)
Anderson1979T40	Study design (cross-sectional; no controls). Study location: Oklahoma City, Oklahoma (USA)
Asch-Goodkin2006T703	Not a study
Barton1990T21	Study design: not RCT, CBA or ITS. Study location: USA
Bell1993T59	Study design (survey). Study location: Wentworth Health Area, New South Wales (Australia)
Berg2004T701	Intervention: mailed marketing piece; Primary outcomes = inpatient hospitalizations and emergency department visits; secondary outcomes = immunizations; clustered participants (by family) (USA)
Berhane1993T13	Sticker intervention did not meet intervention type inclusion criteria. Study location: Lideta & Nefas districts of Addis Ababa (Ethiopia)
Britto2006T704	Study design unclear, possible ITS; however, package of interventions tested (cannot determine effects of patient reminder); no true baseline data (USA)
Browngoehl1997T98	Not RCT, CBA or ITS; retrospective cohort study design. Study location: Pennsylvania (USA)
Bussey1979T64	Outcome=measles (not vaccination). Study location: England & Wales
Byrne1970T83	Not CBA, RCT or ITS. Study location: Rhode Island (USA).
Charles1994T100	Studied required signed written consent vs. not. Letters sent to study and control subjects. Study location: Toronto (Canada)
Cleary1995T4	Study Design (Not RCT, CBA, or ITS). Study location: Rochester, New York area (USA)
Crittenden1994T109	Not RCT, CBA or ITS. Study location: north east Essex
Dini1995T74	Outcome = kept immunization appointments. Study location: Georgia (USA)
Frank1985T24	Methods described in a separate report. Study location: Ontario (Canada)
Frank2004T507	Intervention: provider reminders. Study location: Australia
Franzini2000T705	Cost & cost-effectiveness study (USA)
Garr1992T62	Study design (not RCT, CBA or ITS). Study location: South Carolina (USA)

(*Continued*)

Gerace1988T91	Not RCT, CBA or ITS study design. Study location: Western Ontario (Canada)
Grabowski1996T2	Editorial
Gupta2003T504	Study of mammography with discussions of immunizations. Study location: Manitoba (Canada)
Hak1997T97	Not RCT, CBA or ITS; retrospective questionnaire. Study location: one third of all 4,758 general practitioners in The Netherlands
Harper1994T53	Study design (2 interventions; no real control group). Study location: Minnesota (USA)
Honkanen1997T70	Study design: controlled study without baseline data. Study location: Northern Finland
Hutchinson1995T55	Study design (survey). Study location: Washington state (USA)
Hutchison1991T72	Longitudinal study without control group. Study location: Ontario (Canada)
Johnson2003T509	Study design & intervention: the patient reminder (letter) was compared to an education campaign plus letter. A no-letter comparison group was not part of a RCT, CBA or ITS. Study location: Montana (USA)
Kempe2004T708	Not patient reminders; not RCT, CBA, or ITS (USA)
Kennedy1994T110	Not RCT, CBA or ITS. Study location: Pennsylvania (USA).
Kljakovic1994T8	Study design (cohort study). Study location: Wellington (New Zealand)
Kreuter1996T1	Study design (pre-test post-test). Study Location: St. Louis, Missouri (USA)
Larson1979T41	Study design (cross sectional). Study Location: Washington state (USA)
Leirer1989T73	Study design: Not RCT, CBA or ITS. Study location: California (USA)
Loeser1983T60	Registry; survey. Study location: Montreal (Canada).
LudwigBeymer2001T508	Study design: Not RCT, CBA or ITS. Study location: Chicago, Illinois (USA)
MacIntyre2003T510	Study design: compared 2 reminders; no real control group. Study location: Melbourne (Australia)
Macknin2000T710	Telephone reminder focused on well-child visits (USA)
Margolis2004T503	Patient reminders were likely to be integrated into a broader intervention (continuing medical education & office systems); immunization outcomes cannot be clearly linked with patient reminders. Study Location: 2 regions of North Carolina (USA)
Marshall1995T43	Study design (not RCT, CBA or ITS). Study location: Hong Kong

(*Continued*)

McDowell1990T81	Sustainability of previous study. Study location: Ontario (Canada)
Melnikow2000T711	Not RCT, CBA, or ITS; multiple interventions & outcomes; complete data not presented
Moore1981T108	Not RCT, CBA or ITS. Study location: Texas public health region 5 (USA)
Newman1983T84	Not RCT, ITS, or CBA; study of computer intervention. Study location: Harrogate Health District (England & Wales)
Nichol1990T20	Study design (not RCT, CBA, or ITS). Study location: Minneapolis, Minnesota (USA)
Nichol1992T14	Study design (not RCT, CBA or ITS): cross-sectional. Study location: Minneapolis, Minnesota (USA)
Norman1995T58	Report; not a study. Location: Swedish Family Medicine Clinic (USA)
Ornstein1995T44	Study design (ITS with < 2 data points). Study location: South Carolina (USA)
Paunio1991T89	Study design not clear. Polio campaign may distort findings. Study location: Finland
Payne1993T65	Study: validation of computer tracking system. Study location: Group Health Cooperative of Puget Sound (USA)
Phibbs2006T712	Post-hoc analysis of a clustered RCT; tracked "inactive" infants; not focused specifically on patient reminders; Denver, Colorado (USA)
Pierce1996T90	Intervention is Standards for Pediatric Immunization Practice rather than patient reminders. Study location: New Mexico (USA)
Quinley2004T501	Intervention was audit & feedback with supplemental outreach to the providers in the intervention group. Study location: New York state (USA)
Reid1984T37	Study design (not RCT, CBA, ITS; no control group). Study location: Lower Hutt (New Zealand?)
Rhew1999T713	"Prospective controlled trial" (possibly prospective cohort study); no true control group; not patient reminders, Los Angeles, California (USA)
Rosenberg1995T6	Study design (not RCT, CBA, or true ITS--not enough data points). Study location: New York City, New York (USA)
Saunders1970T80	Cost analysis. Study location: England and Wales.
Sellors1997T71	RCT of 2 interventions (no control). Study location: Hamilton, Ontario (Canada)
Shefer2006T714	Not a study; results of a symposium (USA)
Stewart1997T102	Not RCT, ITS or CBA. Compared two interventions. Study location: Ontario (Canada)

(*Continued*)

Szilagyi2002T717	Electronic abstract only (USA)
Thompson1995T94	Discussion of large # of preventive practices over 20 years, but study details not reported. Study location: Group Health Cooperative of Puget Sound (USA)
Tucker1987T75	Study design (post-test; mailed cues). Study location: St. Joseph's Hospital Family Practice Residency, Syracuse, New York (USA)
Turner1990T22	Intervention=patient carried cards (not true patient reminder). Study location: Greenville, North Carolina (USA)
Turner1994T48	Intervention=patient carried cards; No real control group. Study location: North Carolina (USA)
VanEssen1997T715	"non-equivalent control group design;" pre-test, post-test; Interventions include organizational changes, such as use of mail prompt; stocking of vaccine, and others; therefore, not able to specifically measure effect of mail prompt (Netherlands)
Vernon1976T106	Not RCT, CBA or ITS; no control group; not patient reminder-recall intervention study. Study location: Denver elementary schools, Colorado (USA)
Vilella2004T506	Study design: not RCT, CBA or ITS. Study location: Barcelona (Spain)
Vincent1995T3	Study design (pre-test post-test). Study location: Seattle, Washington (USA)
Waterman1996T103	Multiple interventions. Study location: San Diego, California (USA)
Wilcox2001T502	This paper reported data on a community outreach intervention. Study location: Philadelphia, Pennsylvania (USA)
Wojciechowski1993T88	Published abstract; manuscript unpublished. Study location: South Carolina (USA)
Yokley1984T79	Outcome: # immunization visits & # of immunizations. Study location: Ohio (USA)
Zimmerman2003T505	Study design not RCT, CBA or ITS; not true control group; interventions varied by practice, with the possibility of patient reminders being included. Study location: Pittsburgh, Pennsylvania (USA)

DATA AND ANALYSES

Comparison 1. postcard reminder vs. control

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Immunized	6	20749	Odds Ratio (M-H, Random, 95% CI)	1.44 [1.09, 1.89]
1.1 Influenza-child	0	0	Odds Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
1.2 Preschool-child	3	1484	Odds Ratio (M-H, Random, 95% CI)	1.70 [0.85, 3.42]
1.3 Influenza-adult	3	19265	Odds Ratio (M-H, Random, 95% CI)	1.33 [0.91, 1.93]
1.4 Other-adult	0	0	Odds Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]

Comparison 2. letter reminders vs. control

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Immunized	18	28329	Odds Ratio (M-H, Random, 95% CI)	1.79 [1.50, 2.15]
1.1 Influenza-child	4	7264	Odds Ratio (M-H, Random, 95% CI)	2.18 [1.29, 3.70]
1.2 Preschool-child	5	1311	Odds Ratio (M-H, Random, 95% CI)	1.58 [1.26, 1.99]
1.3 Influenza-adult	9	18319	Odds Ratio (M-H, Random, 95% CI)	1.78 [1.32, 2.40]
1.4 Other-adult	2	1435	Odds Ratio (M-H, Random, 95% CI)	3.45 [1.51, 7.88]

Comparison 3. phone reminders vs. control

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Immunized	4	2465	Odds Ratio (M-H, Random, 95% CI)	1.92 [1.20, 3.07]
1.1 Influenza-child	0	0	Odds Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
1.2 Preschool-child	1	103	Odds Ratio (M-H, Random, 95% CI)	4.25 [1.85, 9.75]
1.3 Influenza-adult	2	1838	Odds Ratio (M-H, Random, 95% CI)	1.64 [0.84, 3.22]
1.4 Other-adult	1	524	Odds Ratio (M-H, Random, 95% CI)	1.59 [1.00, 2.55]

Comparison 4. autodialer vs. control

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Immunized	4	11589	Odds Ratio (M-H, Random, 95% CI)	1.29 [1.09, 1.53]
1.1 Influenza-child	0	0	Odds Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
1.2 Preschool-child	3	8583	Odds Ratio (M-H, Random, 95% CI)	1.43 [1.30, 1.57]
1.3 Influenza-adult	0	0	Odds Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
1.4 Other-adult	0	0	Odds Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
1.5 Adolescent	1	3006	Odds Ratio (M-H, Random, 95% CI)	1.14 [0.98, 1.31]

Comparison 5. card & phone vs. control

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Immunized	5	3535	Odds Ratio (M-H, Random, 95% CI)	1.45 [1.11, 1.89]
1.1 Influenza-child	0	0	Odds Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
1.2 Preschool-child	5	3535	Odds Ratio (M-H, Random, 95% CI)	1.45 [1.11, 1.89]
1.3 Influenza-adult	0	0	Odds Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
1.4 Other-adult	0	0	Odds Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]

Comparison 6. patient & provider reminder vs. control

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Immunized	3	3057	Odds Ratio (M-H, Random, 95% CI)	3.65 [1.54, 8.67]
1.1 Influenza-child	0	0	Odds Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
1.2 Preschool-child	2	2689	Odds Ratio (M-H, Random, 95% CI)	3.57 [1.03, 12.41]
1.3 Influenza-adult	1	104	Odds Ratio (M-H, Random, 95% CI)	3.4 [1.10, 10.50]
1.4 Other-adult	1	264	Odds Ratio (M-H, Random, 95% CI)	4.34 [1.15, 16.42]

Comparison 7. Patient Reminders (summary) vs. control

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Immunized	33	60922	Odds Ratio (M-H, Random, 95% CI)	1.57 [1.41, 1.75]
1.1 Influenza-child	4	7264	Odds Ratio (M-H, Random, 95% CI)	2.18 [1.29, 3.70]
1.2 Preschool-child	15	15704	Odds Ratio (M-H, Random, 95% CI)	1.47 [1.28, 1.68]
1.3 Influenza-adult	12	32989	Odds Ratio (M-H, Random, 95% CI)	1.66 [1.31, 2.09]
1.4 Other-adult	3	1959	Odds Ratio (M-H, Random, 95% CI)	2.19 [1.21, 3.99]
1.5 Adolescent	1	3006	Odds Ratio (M-H, Random, 95% CI)	1.14 [0.98, 1.31]

Comparison 8. tracking and outreach vs. control

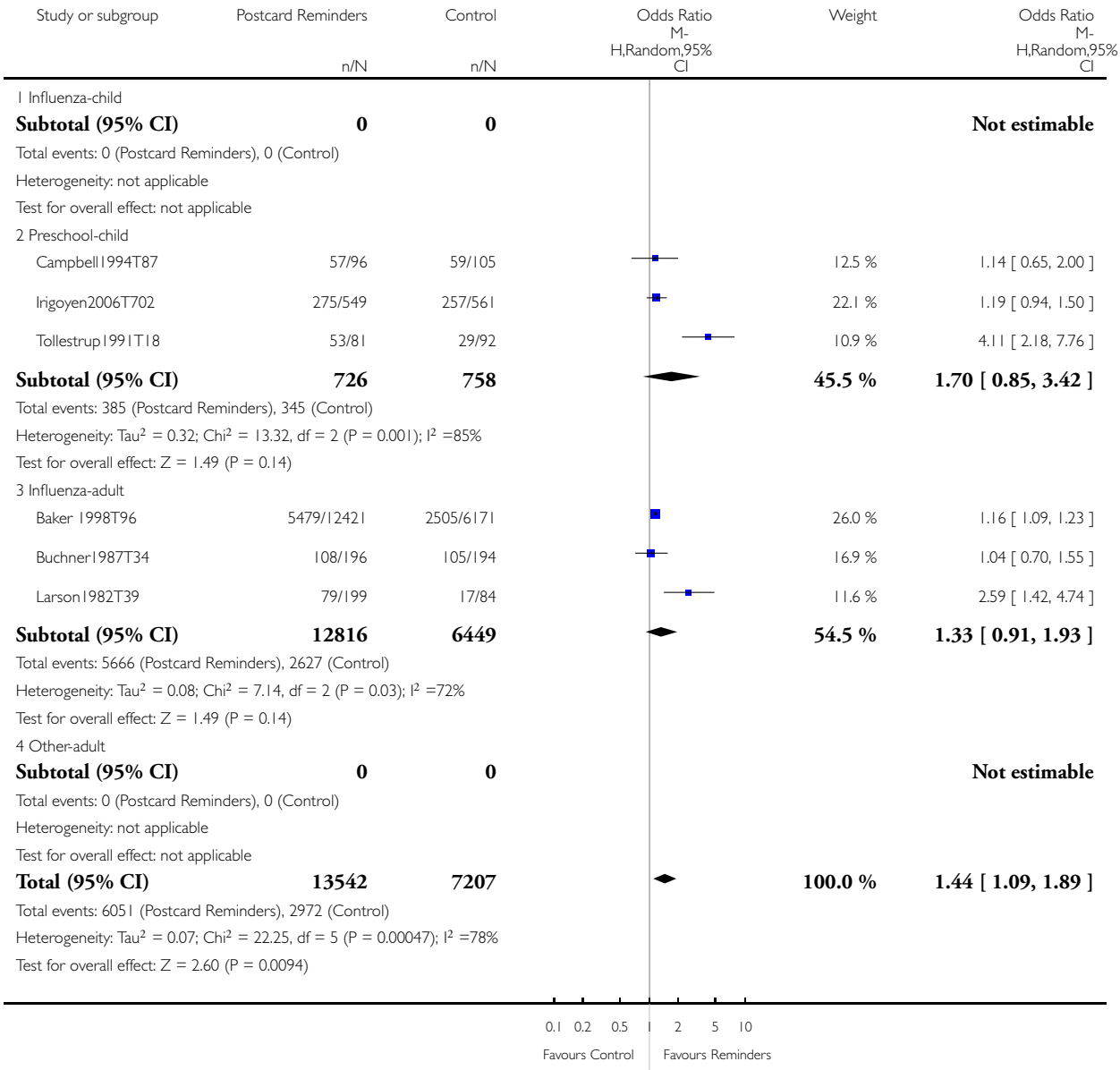
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Immunized	2	1894	Odds Ratio (M-H, Random, 95% CI)	1.37 [0.98, 1.92]
1.1 Influenza-child	0	0	Odds Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
1.2 Preschool-child	2	1894	Odds Ratio (M-H, Random, 95% CI)	1.37 [0.98, 1.92]
1.3 Influenza-adult	0	0	Odds Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
1.4 Other-adult	0	0	Odds Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]

Analysis 1.1. Comparison 1 postcard reminder vs. control, Outcome 1 Immunized.

Review: Patient reminder and recall systems to improve immunization rates

Comparison: 1 postcard reminder vs. control

Outcome: 1 Immunized

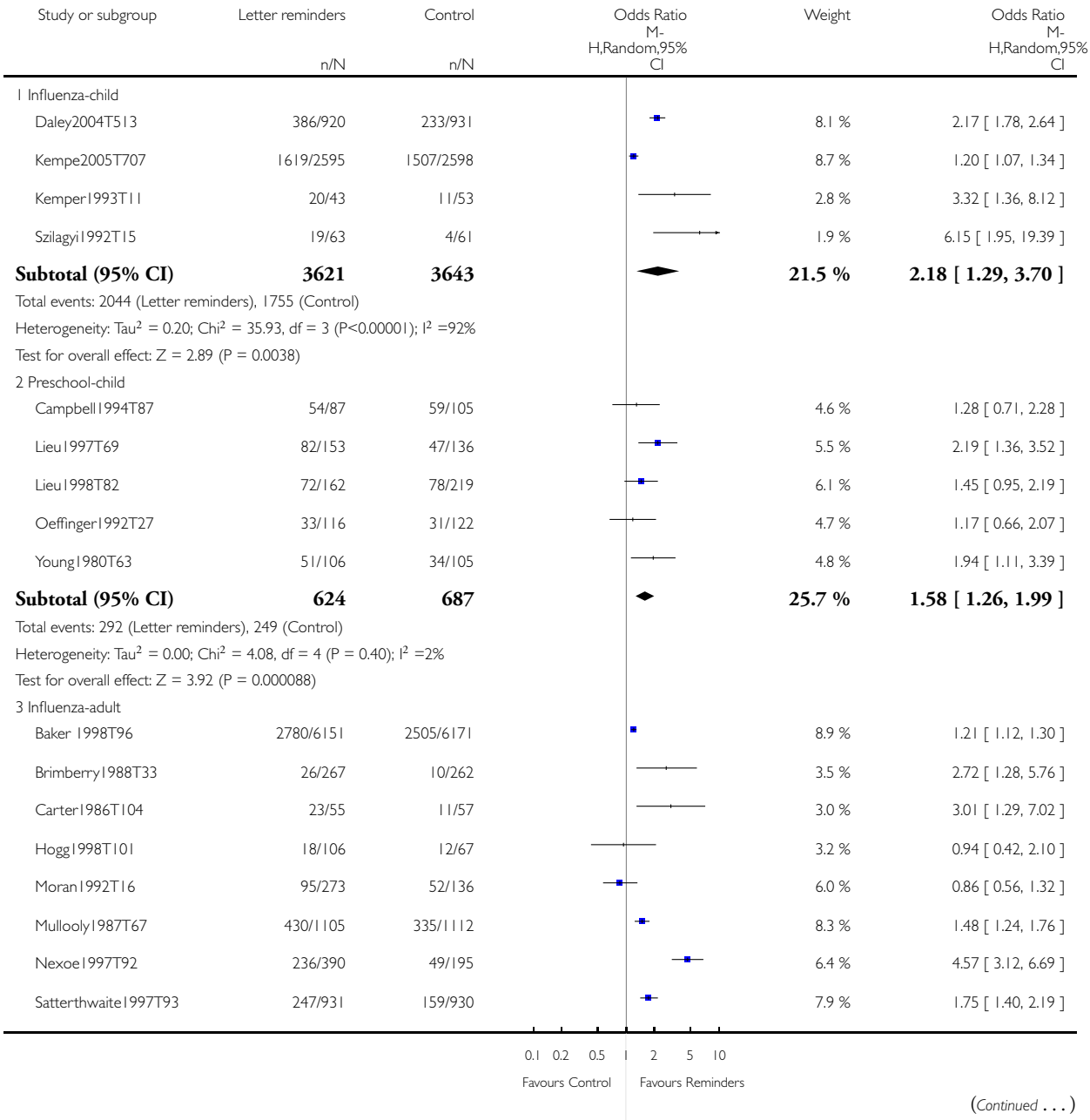


Analysis 2.1. Comparison 2 letter reminders vs. control, Outcome 1 Immunized.

Review: Patient reminder and recall systems to improve immunization rates

Comparison: 2 letter reminders vs. control

Outcome: 1 Immunized



(*Continued . . .*)

(. . . *Continued*)

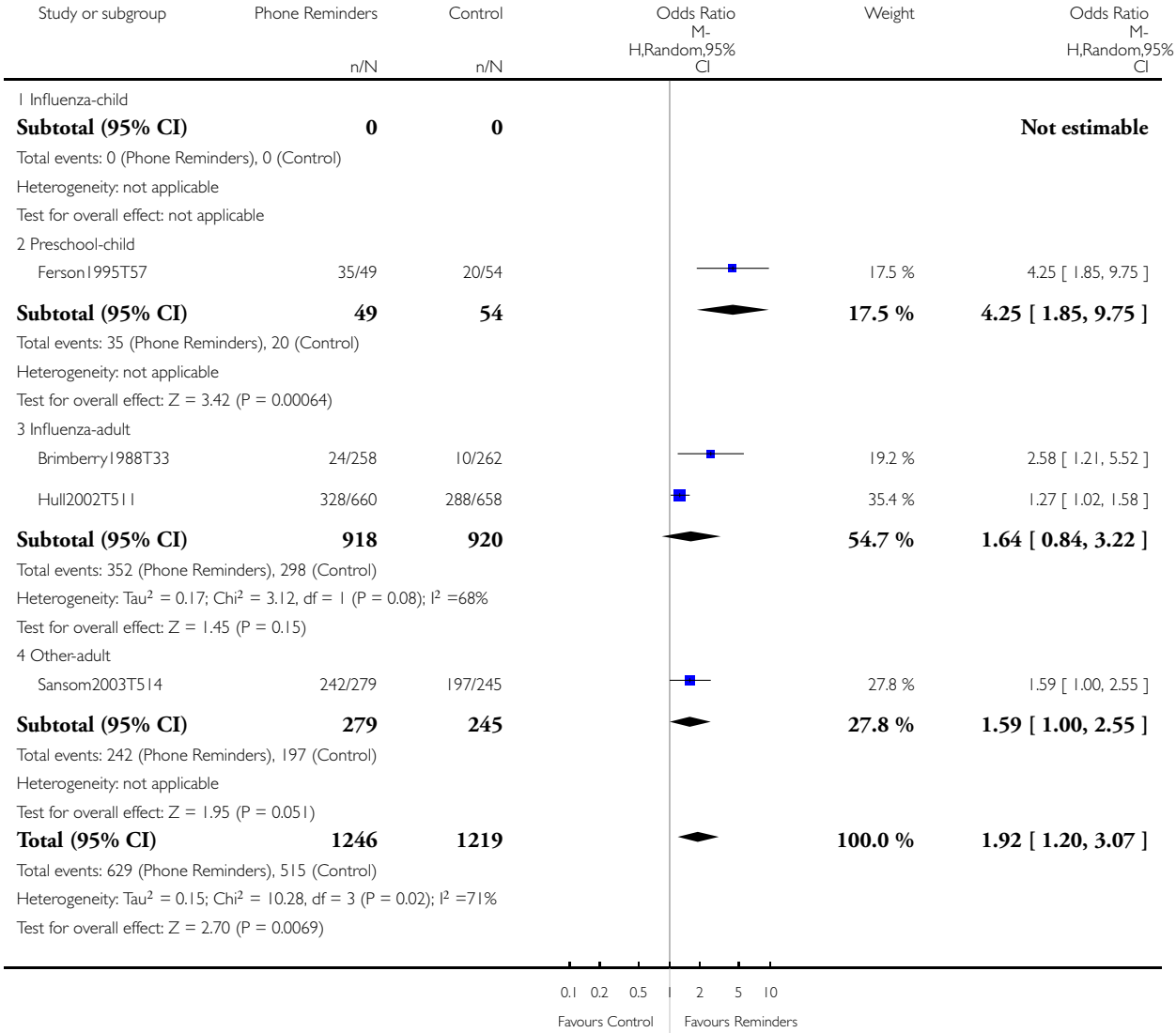
Study or subgroup	Letter reminders n/N	Control n/N	Odds Ratio M-H,Random,95% CI	Weight	Odds Ratio M-H,Random,95% CI
Siebers1985T36	23/72	4/39		1.9 %	4.11 [1.30, 12.93]
Subtotal (95% CI)	**9350**	**8969**		**49.0 %**	**1.78 [1.32, 2.40]**
Total events: 3878 (Letter reminders), 3137 (Control)					
Heterogeneity: $Tau^2 = 0.14$; $Chi^2 = 69.75$, df = 8 ($P<0.00001$); $I^2 = 89\%$					
Test for overall effect: Z = 3.80 (P = 0.00014)					
4 Other-adult					
Hogg1998T101	21/866	4/458		2.1 %	2.82 [0.96, 8.27]
Siebers1985T36	20/72	3/39		1.6 %	4.62 [1.28, 16.70]
Subtotal (95% CI)	**938**	**497**		**3.7 %**	**3.45 [1.51, 7.88]**
Total events: 41 (Letter reminders), 7 (Control)					
Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.33$, df = 1 ($P = 0.56$); $I^2 = 0.0\%$					
Test for overall effect: Z = 2.95 (P = 0.0032)					
Total (95% CI)	**14533**	**13796**		**100.0 %**	**1.79 [1.50, 2.15]**
Total events: 6255 (Letter reminders), 5148 (Control)					
Heterogeneity: $Tau^2 = 0.09$; $Chi^2 = 118.07$, df = 19 ($P<0.00001$); $I^2 = 84\%$					
Test for overall effect: Z = 6.37 (P < 0.00001)					

Analysis 3.1. Comparison 3 phone reminders vs. control, Outcome 1 Immunized.

Review: Patient reminder and recall systems to improve immunization rates

Comparison: 3 phone reminders vs. control

Outcome: 1 Immunized



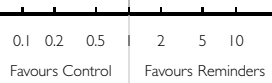
Analysis 4.1. Comparison 4 autodialer vs. control, Outcome 1 Immunized.

Review: Patient reminder and recall systems to improve immunization rates

Comparison: 4 autodialer vs. control

Outcome: 1 Immunized

Study or subgroup	Autodialer Reminders n/N	Control n/N	Odds Ratio M-H,Random,95% CI	Weight	Odds Ratio M-H,Random,95% CI
1 Influenza-child					
Subtotal (95% CI)	**0**	**0**			**Not estimable**
Total events: 0 (Autodialer Reminders), 0 (Control)					
Heterogeneity: not applicable					
Test for overall effect: not applicable					
2 Preschool-child					
Lieu1998T82	72/165	78/219		12.5 %	1.40 [0.93, 2.12]
Linkins1994T49	1684/4636	955/3366		43.1 %	1.44 [1.31, 1.59]
Stehr-Green1993T10	46/101	41/96		7.6 %	1.12 [0.64, 1.97]
Subtotal (95% CI)	**4902**	**3681**		**63.3 %**	**1.43 [1.30, 1.57]**
Total events: 1802 (Autodialer Reminders), 1074 (Control)					
Heterogeneity: $Tau^2 = 0.0$; $Chi^2 = 0.74$, df = 2 (P = 0.69); $I^2 = 0.0\%$					
Test for overall effect: Z = 7.58 (P < 0.00001)					
3 Influenza-adult					
Subtotal (95% CI)	**0**	**0**			**Not estimable**
Total events: 0 (Autodialer Reminders), 0 (Control)					
Heterogeneity: not applicable					
Test for overall effect: not applicable					
4 Other-adult					
Subtotal (95% CI)	**0**	**0**			**Not estimable**
Total events: 0 (Autodialer Reminders), 0 (Control)					
Heterogeneity: not applicable					
Test for overall effect: not applicable					
5 Adolescent					
Szilagyi2006T718	853/1496	813/1510		36.7 %	1.14 [0.98, 1.31]
Subtotal (95% CI)	**1496**	**1510**		**36.7 %**	**1.14 [0.98, 1.31]**
Total events: 853 (Autodialer Reminders), 813 (Control)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.75 (P = 0.080)					
Total (95% CI)	**6398**	**5191**		**100.0 %**	**1.29 [1.09, 1.53]**
Total events: 2655 (Autodialer Reminders), 1887 (Control)					
Heterogeneity: $Tau^2 = 0.01$; $Chi^2 = 7.58$, df = 3 (P = 0.06); $I^2 = 60\%$					
Test for overall effect: Z = 2.96 (P = 0.0030)					

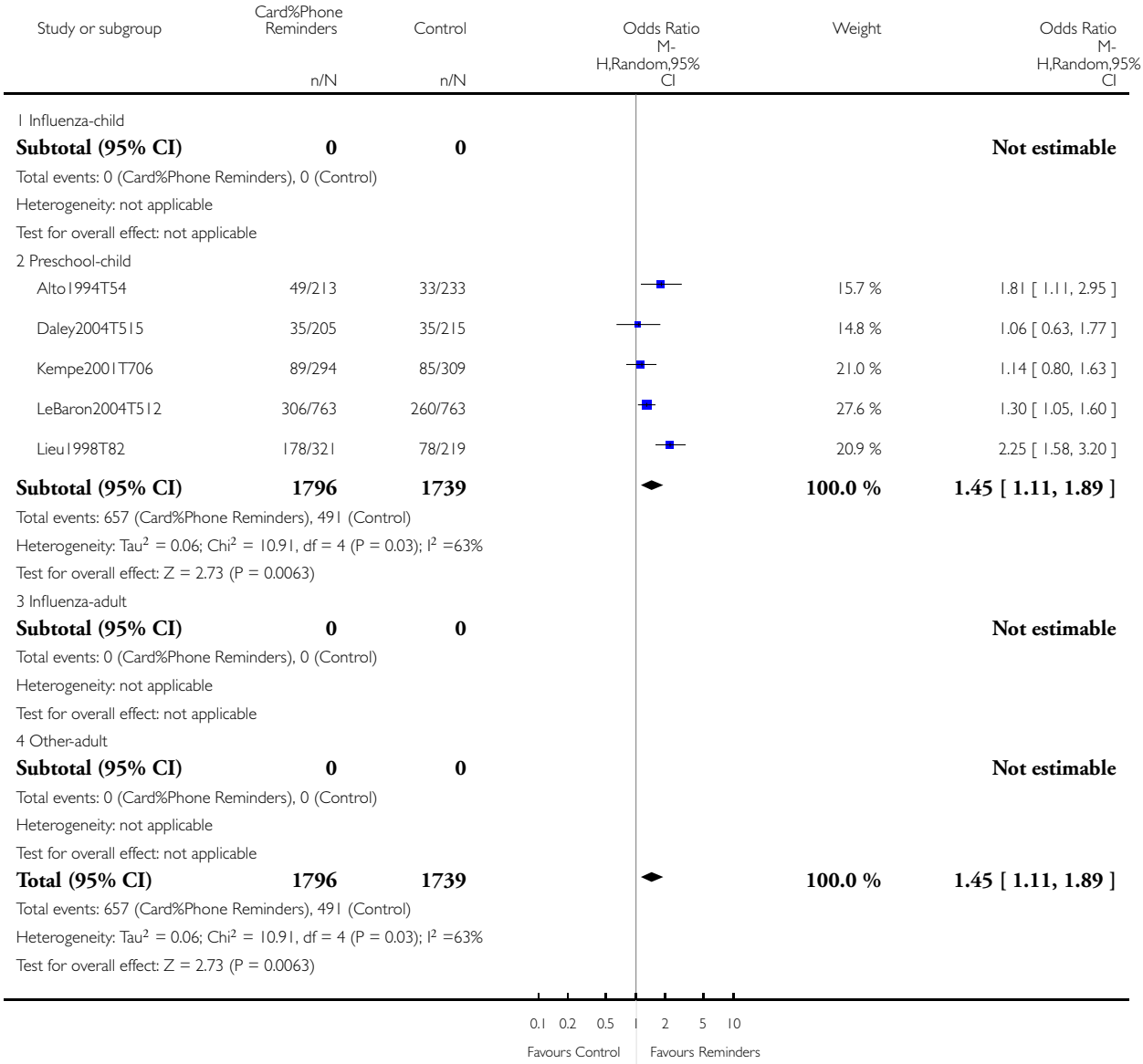


Analysis 5.1. Comparison 5 card & phone vs. control, Outcome 1 Immunized.

Review: Patient reminder and recall systems to improve immunization rates

Comparison: 5 card % phone vs. control

Outcome: 1 Immunized



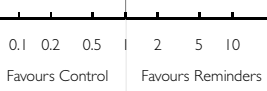
Analysis 6.1. Comparison 6 patient & provider reminder vs. control, Outcome 1 Immunized.

Review: Patient reminder and recall systems to improve immunization rates

Comparison: 6 patient % provider reminder vs. control

Outcome: 1 Immunized

Study or subgroup	Patient % Provider R n/N	Control n/N	Odds Ratio M-H,Random,95% CI	Weight	Odds Ratio M-H,Random,95% CI
1 Influenza-child					
Subtotal (95% CI)	**0**	**0**			**Not estimable**
Total events: 0 (Patient % Provider R), 0 (Control)					
Heterogeneity: not applicable					
Test for overall effect: not applicable					
2 Preschool-child					
Rodewald1999T95	616/648	532/719		30.0 %	6.77 [4.57, 10.02]
Soljak1987T35	539/709	382/613		31.2 %	1.92 [1.51, 2.43]
Subtotal (95% CI)	**1357**	**1332**		**61.1 %**	**3.57 [1.03, 12.41]**
Total events: 1155 (Patient % Provider R), 914 (Control)					
Heterogeneity: Tau^2 = 0.78; Chi^2 = 29.55, df = 1 (P<0.00001); I^2 =97%					
Test for overall effect: Z = 2.00 (P = 0.046)					
3 Influenza-adult					
Becker1989T23	12/48	5/56		20.7 %	3.40 [1.10, 10.50]
Subtotal (95% CI)	**48**	**56**		**20.7 %**	**3.40 [1.10, 10.50]**
Total events: 12 (Patient % Provider R), 5 (Control)					
Heterogeneity: not applicable					
Test for overall effect: Z = 2.13 (P = 0.033)					
4 Other-adult					
Becker1989T23	9/112	3/152		18.2 %	4.34 [1.15, 16.42]
Subtotal (95% CI)	**112**	**152**		**18.2 %**	**4.34 [1.15, 16.42]**
Total events: 9 (Patient % Provider R), 3 (Control)					
Heterogeneity: not applicable					
Test for overall effect: Z = 2.16 (P = 0.031)					
Total (95% CI)	**1517**	**1540**		**100.0 %**	**3.65 [1.54, 8.67]**
Total events: 1176 (Patient % Provider R), 922 (Control)					
Heterogeneity: Tau^2 = 0.61; Chi^2 = 30.15, df = 3 (P<0.00001); I^2 =90%					
Test for overall effect: Z = 2.94 (P = 0.0033)					



Analysis 7.1. Comparison 7 Patient Reminders (summary) vs. control, Outcome 1 Immunized.

Review: Patient reminder and recall systems to improve immunization rates

Comparison: 7 Patient Reminders (summary) vs. control

Outcome: 1 Immunized

Study or subgroup	Patient Reminder Sum n/N	Control n/N	Odds Ratio M-H,Random,95% CI	Weight	Odds Ratio M-H,Random,95% CI
1 Influenza-child					
Daley2004T513	386/920	233/931		4.6 %	2.17 [1.78, 2.64]
Kempe2005T707	1619/2595	1507/2598		5.1 %	1.20 [1.07, 1.34]
Kemper1993T11	20/43	11/53		1.2 %	3.32 [1.36, 8.12]
Szilagyi1992T15	19/63	4/61		0.8 %	6.15 [1.95, 19.39]
Subtotal (95% CI)	**3621**	**3643**		**11.6 %**	**2.18 [1.29, 3.70]**
Total events: 2044 (Patient Reminder Sum), 1755 (Control)					
Heterogeneity: $Tau^2 = 0.20$; $Chi^2 = 35.93$, df = 3 (P<0.00001); $I^2 = 92\%$					
Test for overall effect: Z = 2.89 (P = 0.0038)					
2 Preschool-child					
Alto1994T54	49/213	33/233		2.6 %	1.81 [1.11, 2.95]
Campbell1994T87	111/183	59/105		2.6 %	1.20 [0.74, 1.95]
Daley2004T515	35/205	35/215		2.4 %	1.06 [0.63, 1.77]
Ferson1995T57	35/49	20/54		1.3 %	4.25 [1.85, 9.75]
Irigoyen2006T702	275/549	257/561		4.3 %	1.19 [0.94, 1.50]
Kempe2001T706	89/294	85/309		3.4 %	1.14 [0.80, 1.63]
LeBaron2004T512	599/1527	260/763		4.7 %	1.25 [1.04, 1.50]
Lieu1997T69	82/153	47/136		2.6 %	2.19 [1.36, 3.52]
Lieu1998T82	322/748	78/219		3.7 %	1.37 [1.00, 1.87]
Linkins1994T49	1684/4636	955/3366		5.2 %	1.44 [1.31, 1.59]
Oeffinger1992T27	33/116	31/122		2.1 %	1.17 [0.66, 2.07]
Stehr-Green1993T10	46/101	41/96		2.2 %	1.12 [0.64, 1.97]
Tollestrup1991T18	53/81	29/92		1.9 %	4.11 [2.18, 7.76]
Wood1998T105	119/186	92/181		3.0 %	1.72 [1.13, 2.61]
Young1980T63	51/106	34/105		2.2 %	1.94 [1.11, 3.39]
Subtotal (95% CI)	**9147**	**6557**		**44.2 %**	**1.47 [1.28, 1.68]**

(*Continued* . . .)

(. . . *Continued*)

Study or subgroup	Patient Reminder Sum n/N	Control n/N	Odds Ratio M-H,Random,95% CI	Weight	Odds Ratio M-H,Random,95% CI
Total events: 3583 (Patient Reminder Sum), 2056 (Control)					
Heterogeneity: $Tau^2 = 0.03$; $Chi^2 = 32.09$, df = 14 (P = 0.004); $I^2 = 56\%$					
Test for overall effect: Z = 5.44 (P < 0.00001)					
3 Influenza-adult					
Baker 1998T96	8259/18572	2505/6171		5.3 %	1.17 [1.11, 1.24]
Brimberry1988T33	50/525	10/262		1.7 %	2.65 [1.32, 5.32]
Buchner1987T34	108/196	105/194		3.1 %	1.04 [0.70, 1.55]
Carter1986T104	23/55	11/57		1.3 %	3.01 [1.29, 7.02]
Hogg1998T101	18/106	12/67		1.4 %	0.94 [0.42, 2.10]
Hull2002T511	328/660	288/658		4.4 %	1.27 [1.02, 1.58]
Larson1982T39	79/199	17/84		2.0 %	2.59 [1.42, 4.74]
Moran1992T16	95/273	52/136		2.9 %	0.86 [0.56, 1.32]
Mullooly1987T67	430/1105	335/1112		4.7 %	1.48 [1.24, 1.76]
Nexoe1997T92	236/390	49/195		3.2 %	4.57 [3.12, 6.69]
Satterthwaite1997T93	247/931	159/930		4.4 %	1.75 [1.40, 2.19]
Siebers1985T36	23/72	4/39		0.8 %	4.11 [1.30, 12.93]
Subtotal (95% CI)	**23084**	**9905**		**35.1 %**	**1.66 [1.31, 2.09]**
Total events: 9896 (Patient Reminder Sum), 3547 (Control)					
Heterogeneity: $Tau^2 = 0.11$; $Chi^2 = 83.43$, df = 11 (P<0.00001); $I^2 = 87\%$					
Test for overall effect: Z = 4.26 (P = 0.000020)					
4 Other-adult					
Hogg1998T101	21/866	4/458		0.9 %	2.82 [0.96, 8.27]
Sansom2003T514	242/279	197/245		2.7 %	1.59 [1.00, 2.55]
Siebers1985T36	20/72	3/39		0.6 %	4.62 [1.28, 16.70]
Subtotal (95% CI)	**1217**	**742**		**4.2 %**	**2.19 [1.21, 3.99]**
Total events: 283 (Patient Reminder Sum), 204 (Control)					
Heterogeneity: $Tau^2 = 0.10$; $Chi^2 = 2.93$, df = 2 (P = 0.23); $I^2 = 32\%$					
Test for overall effect: Z = 2.57 (P = 0.010)					
5 Adolescent					
Szilagyi2006T718	853/1496	813/1510		4.9 %	1.14 [0.98, 1.31]
Subtotal (95% CI)	**1496**	**1510**		**4.9 %**	**1.14 [0.98, 1.31]**
Total events: 853 (Patient Reminder Sum), 813 (Control)					
Heterogeneity: not applicable					
Test for overall effect: Z = 1.75 (P = 0.080)					
Total (95% CI)	**38565**	**22357**		**100.0 %**	**1.57 [1.41, 1.75]**
Total events: 16659 (Patient Reminder Sum), 8375 (Control)					

(*Continued* . . .)

(. . . *Continued*)

Study or subgroup	Patient Reminder Sum n/N	Control n/N	Odds Ratio M-H,Random,95% CI	Weight	Odds Ratio M-H,Random,95% CI
Heterogeneity: Tau² = 0.06; Chi² = 169.91, df = 34 (P<0.00001); I² =80%					
Test for overall effect: Z = 8.20 (P < 0.00001)					

Analysis 8.1. Comparison 8 tracking and outreach vs. control, Outcome 1 Immunized.

Review: Patient reminder and recall systems to improve immunization rates

Comparison: 8 tracking and outreach vs. control

Outcome: 1 Immunized

Study or subgroup	Tracking % Outreach n/N	Control n/N	Odds Ratio M-H,Random,95% CI	Weight	Odds Ratio M-H,Random,95% CI
1 Influenza-child					
Subtotal (95% CI)	**0**	**0**			**Not estimable**
Total events: 0 (Tracking % Outreach), 0 (Control)					
Heterogeneity: not applicable					
Test for overall effect: not applicable					
2 Preschool-child					
LeBaron2004T512	293/764	260/763		63.4 %	1.20 [0.98, 1.48]
Wood1998T105	119/186	92/181		36.6 %	1.72 [1.13, 2.61]
Subtotal (95% CI)	**950**	**944**		**100.0 %**	**1.37 [0.98, 1.92]**
Total events: 412 (Tracking % Outreach), 352 (Control)					
Heterogeneity: Tau² = 0.03; Chi² = 2.23, df = 1 (P = 0.14); I² =55%					
Test for overall effect: Z = 1.84 (P = 0.066)					
3 Influenza-adult					
Subtotal (95% CI)	**0**	**0**			**Not estimable**
Total events: 0 (Tracking % Outreach), 0 (Control)					
Heterogeneity: not applicable					
Test for overall effect: not applicable					

(*Continued* . . .)

(. . . *Continued*)

Study or subgroup	Tracking % Outreach n/N	Control n/N	Odds Ratio M-H,Random,95% CI	Weight	Odds Ratio M-H,Random,95% CI
4 Other-adult					
Subtotal (95% CI)	**0**	**0**			**Not estimable**
Total events: 0 (Tracking % Outreach), 0 (Control)					
Heterogeneity: not applicable					
Test for overall effect: not applicable					
Total (95% CI)	**950**	**944**		**100.0 %**	**1.37 [0.98, 1.92]**
Total events: 412 (Tracking % Outreach), 352 (Control)					
Heterogeneity: $Tau^2 = 0.03$; $Chi^2 = 2.23$, df = 1 (P = 0.14); $I^2 = 55\%$					
Test for overall effect: Z = 1.84 (P = 0.066)					

FEEDBACK

study arms

Summary

1. There are a couple of labelling problems with the graphs as they appear in MetaView. At the moment the intervention groups retain their default labels: "Treatment" and "Control" and it might be better to change the former to "Reminders". More importantly, though, the labels at the bottom of the graphs have not been changed from the defaults, so they are still "Favours treatment" on the left and "Favours Control" on the right. This is wrong, because the outcome is a good one (immunisation) and it may be confusing to some users to find so many black squares and diamonds sitting above a label that says "Favours Control", when the results and conclusions are that reminders are beneficial in relation to increasing immunisation.
2. The large 4-arm Baker study is commented on a few times in the review and the reviewers do sensitivity analyses that exclude it. However, the whole trial does not seem to be included in the analyses and it probably should be. Specifically, analysis 01.01 (postcards) has a single intervention group versus the single control group (but there seem to have been two postcard groups in the trial) and analysis 08.01 also has a single intervention group when all three reminder groups should probably be included. Although this is unlikely to have any major impact on the general findings, it is likely to affect the values for the Odds Ratios in the text and abstract.

Reply

From the EPOC editorial base and Julie Jacobson Vann
We have made the editorial changes to address the first point.
Concerning the second point. We will work on the best way to include the other study arms of the Baker study, and addition study arms for other multi-arm studies. We anticipate being able to include this in the next version of the library (Issue 2, 2003)

Contributors

Mike Clarke, UK Cochrane Centre

WHAT'S NEW

Date	Event	Description
12 November 2008	Amended	Minor changes

HISTORY

Date	Event	Description
14 August 2008	New citation required but conclusions have not changed	New search July 2007, 4 new studies
12 June 2008	Amended	Converted to new review format.
15 February 2008	New search has been performed	New searches, no changes to findings
25 May 2005	New citation required and conclusions have changed	Substantive amendment

CONTRIBUTIONS OF AUTHORS

Peter Szilagyi: For the initial review: conceiving and designing the review; screening search results; appraising quality of papers; abstracting data from papers; qualititative analysis of cost data; primary writer for the review; securing funding for the review; performing previous studies that relate to the review topic. For the 2005 and 2008 updates: abstracting data from papers and reconciling abstracts between reviewers.

Julie Jacobson Vann: For the initial review: coordinating the review; appraising quality of papers; abstracting data from papers; developing tracking databases; reconciling abstract differences; data management for the review; entering data into RevMan 3.1 and performing edits in RevMan 4.1; analyzing data in EXCEL and RevMan; assisting with writing and editing review. For the 2005 and 2008 updates: reviewing abstracts to identify potentially eligible papers; abstracting data from papers and reconciling abstracts between reviewers; entering data into RevMan4.2.7; re-reviewing previously included studies for cluster randomization design issues; updating manuscript.

Clay Bordley: For the initial review: appraising quality of papers; abstracting data from papers.

Ann Chelminski: For the initial review: coordinating the review at its inception; abstracting studies.

Ron Kraus: For the initial review: developing search strategy; undertaking searches; organizing retrieval of papers; coordinating conference calls.

Peter Margolis: For the initial review: abstracting data from papers.

Lance E. Rodewald: For the initial review: conceiving and designing the review; providing overall direction and context during the first two years of the review process.

Page Abrahamson: For the initial review: converting RevMan 3.1 document to version 4.1; assisting with initial manuscript edits.

DECLARATIONS OF INTEREST

Peter Szilagyi is an author on four of the included studies.

SOURCES OF SUPPORT

Internal sources

- No sources of support supplied

External sources

- Centers for Disease Control & Prevention, USA.
- Health Technology Assessment Programme, UK.

NOTES

Minor update November 2002, changed the titles on the graphs to reflect the interventions.

INDEX TERMS

Medical Subject Headings (MeSH)

*Reminder Systems; Immunization [*utilization]; Immunization Programs [organization & administration]; Randomized Controlled Trials as Topic

MeSH check words

Adult; Child; Humans